
# HOW DOES THE POLITICAL NATURE OF THE DEFENSE ACQUISITION PROCESS AFFECT COST GROWTH

THESIS

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**Abstract**

Many of the major procurement activities and programs of the Department of Defense (DoD) are experiencing cost growth costing the United States (U.S) government money. The purpose of this research was to develop an empirical model in order to explain cost overruns in the DoD major procurement activities and programs.

Specifically, this thesis sought to discover relationships between cost overruns in weapon systems programs and factors that the DoD cannot control, factors that originate from the political nature of the defense acquisition process. The model describes how the political and legislative balances of power between the parties of the Congress, the change of the purchase habits of the DoD from production contracts to service contracts, and the spreading of defense manufacturing capacity across the states of the U.S are related to cost overruns in defense programs.

This research effort studied 193 major weapon system programs from 1970 to 2002 using Ordinary Least Square regression techniques. Results show that a Democratic President leads to a reduction in cost growth, while control of both houses of Congress by one party, or control of the Senate and the office of the President by one party causes cost increases. Furthermore, the results showed that the switch from production contracts to service contracts doesn't reduce cost growth. On the contrary, reduction in the annual cost overrun percentage is observed prior the switch from production contracts to service contracts. Finally research highlighted that the dispersion of defense manufacturing capacity across the country inflates cost overruns in DoD programs.

*To my girlfriend*

**Acknowledgments**

I would like to express my sincere appreciation to my thesis advisor, Major Jeffrey Smith, for his guidance, support, and latitude provided to me throughout the course of this thesis effort. The insight and experience was certainly appreciated. Furthermore I would like to thank you the members of my thesis committee, Dr. Michael Hicks and Dr. William Stockman for their behind the scenes contributions.

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Nikolaos Gounatidis

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# HOW DOES THE POLITICAL NATURE OF THE DEFENSE ACQUISITION PROCESS AFFECT COST GROWTH

## I. Introduction

### Background

Many of the major procurement activities and programs of the Department of Defense (DoD) are experiencing cost growth, causing severe problems for the DoD. Over the last four decades many studies have been conducted trying to identify and control the factors that create cost growth. Many factors have been identified. Some of these are the size (money wise) of the program, schedule length of the program, labor utilization of the industry, complexity and technological capabilities, unexpected inflation, and budget constraints, among others. Most of the factors that have been identified are related to the program itself. Over the years, the DoD instituted several initiatives in order to eliminate or reduce the magnitude of these factors. However other factors cannot be controlled by the DoD, like the political nature of the defense acquisition process. Political authorities like Congress, and specifically the various Congressional Committees, pay special attention to the DoD budgetary process. Their members treat the various defense programs as a way to promote their own interests, the interests of their state and/or district constituency, and the interests of their financial supporters. The spreading of manufacturing capacity across the country is a common strategy followed by politicians in order to maintain the United States (U.S.) defense industry capability and to satisfy the interests of each state. Furthermore over the years there has been an increase in the

importance of outside contractors that provide services to the DoD. Twenty years ago almost two thirds of the defense procurement budget was spent on production contracts. Starting in the early 1990s, there was a switch from production contracts to services contracts. This switch was a political decision made by Congress. Not confined strictly to DoD, the same thing happened throughout the federal government in the frame of "Reinventing Government", started by the Clinton administration and continued by the Bush administration.

As such, we are interested to see if there is a correlation between the political and legislative balances of power and the parties of Congress, who exert control over the defense budget by funding the different defense programs, through their approval of the defense appropriation bill, and the cost growth that is observed over the DoD programs. Furthermore we will examine the relationship between the dispersion of manufacturing capacity across the country and the experience of cost growth in the DoD programs.

**Problem Statement**

In accordance with Congress and DoD directions, cost growth in the various defense programs has to be controlled. The various factors that are responsible for cost growth should be identified and studied. All the aspects of a defense program should be thoroughly examined in order for the responsible authorities to be able to make decisions that will manage cost growth. The specific problem that is addressed through this research is whether the political nature of the defense acquisition process, and more specifically, the existence of different political and legislative balances of power between the Congress parties that make the decisions to allocate money for the defense through

the defense appropriation bills, inflates cost growth in the major procurement activities of the DoD. Furthermore, this research will investigate the existence of any relationship between cost growth and the spreading of the manufacturing capacity of the defense industry across the country and the change of DoD purchasing habits to the switch from production contracts to service contracts. The hypothesis of this research is that the political nature of the defense acquisition process inflates cost growth.

**Research Focus**

This research focuses on major procurement activities and programs of the DoD captured in the Defense Acquisition Executive Summary (DAES) system from 1970 to 2002.

**Preview**

This chapter analyzes the research objectives and the reasons that led to this research. Chapter II contains a summary of the current knowledge. Chapter III describes the methodology used for data collection and details the methodology used to analyze the data and answer the research objectives. Chapter IV provides the results of the analysis performed in Chapter III. Chapter V discusses the conclusions of this research and recommendations for further research.

## II. Literature Review

### Cost Growth

Cost growth in the various procurement activities and more specifically among the major weapon systems of the DoD has been a continuing problem for decades (Calcutt, 1993:i.). Figure 1 provides a graphical representation of the percent cost overruns in the defense programs over time from 1970 to 2002.

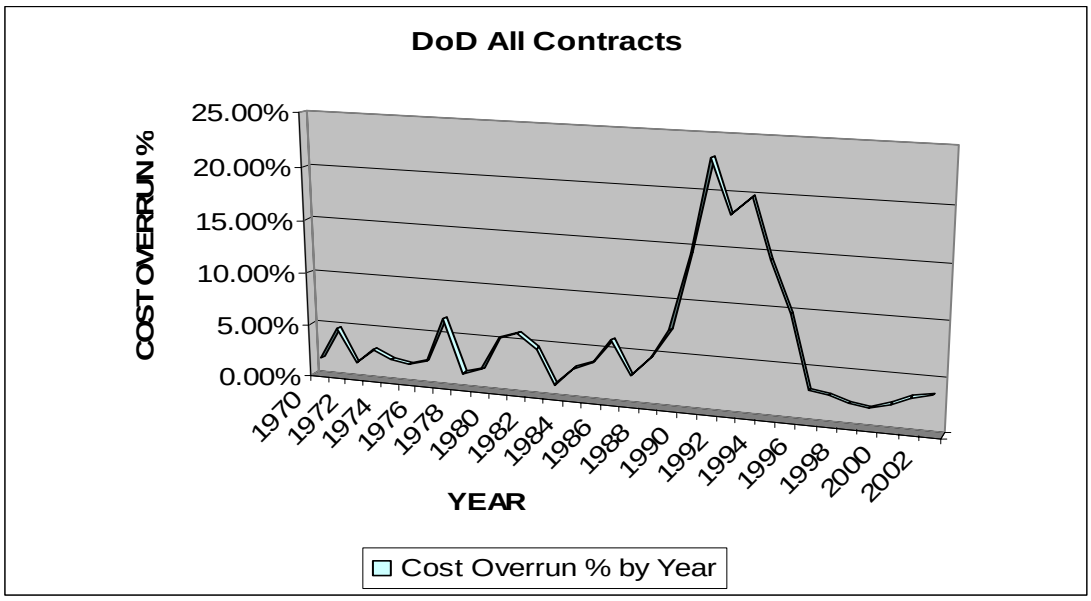



**Figure 1. Cost Growth of DoD Contracts**

However, before an analysis of cost growth in major weapon systems is conducted, let us first define cost growth. The existing literature provides various definitions for cost growth. According to Singer, cost growth is the tendency of the unit cost of a system to increase during the course of the acquisition process (Singer, 1983:2). A study conducted by RAND in 1996 defines cost growth "as the difference between the initial estimate of the total acquisition cost for a program and the most recent or final

estimate adjusted for inflation and quantity changes (RAND, 1996:1)". According to Christensen, Searle, and Vickery (1999:253) the above mentioned definition doesn't make any distinction between uncontrollable and controllable factors that contribute to cost growth between the initial budget and the final cost of the program. Uncontrollable factors can be considered the changes in technology or the scope of the program. Controllable factors can be considered the inadequate planning or poor control techniques. As Searle points out in his thesis, "the cost growth of a completed contract will capture the unplanned cost increases occurring as result of low estimations, changes to the contract, and any management inefficiencies" (Searle, 1997:27). In order to overcome this weakness of cost growth, Christensen uses the term cost overrun on completed defense acquisition contracts. A cost overrun is defined as the difference between the final total budget of a contract and the estimated final cost of the contract (Christensen, Searle, and Vickery, 1999:254). Both of these terms have been used interchangeably by most of the existing literature in this area even though they are measured differently. The key difference between the two measurements is that cost overrun uses the final budget (current budget) whereas; cost growth uses the initial estimate as evidenced by the following equations (Searle, 1997:27).

$$Cost \quad Growth = EAC - Initial \quad Estimate \tag{1}$$

$$Cost \quad Overrun = \frac{BCWP}{(BAC)} - \frac{ACWP}{(EAC)} \tag{2}$$

This research will interchangeably use both of these terms and use the cost overrun concept in all the calculations. The terms used in both of the equations are defined as follows (Glossary Defense Acquisition and Terms, 2003):

**Actual Cost of Work Performed (ACWP):** The cost incurred and recorded in accomplishing the work performed within a given time period.

**Budgeted Cost of Work Performed (BCWP):** A measurement of the work completed, in Earned Value Management (EVM) terminology. BCWP is the value of work performed, or "earned" when compared to the original plan, that is, the Budgeted Cost of Work Scheduled (BCWS). The BCWP is also known as the Earned Value.

**Budgeted Cost of Work Scheduled (BCWS):** The sum of the budgets for all work packages, planning packages, etc, scheduled to be accomplished, plus the amount of level of effort and appropriate effort scheduled to be accomplished within a given time period.

**Budget at Completion (BAC):** The sum of budgets for all works packages, planning packages, etc., for the entire contract excluding the management reserve budget. This is the baseline plan for the entire effort

**Estimate at Completion (EAC):** Actual direct costs, plus indirect cost that are allocable to the contract, plus the estimate of costs for authorized work remaining.

Appendix A provides a graphical representation of the above terms. It visually portrays all the terms on one graph, providing sufficient information to comprehensively understand them. The final budget of a program is considered to be a better estimate of what a well-managed contract should cost because it includes all the revisions, updates,

and all the authorized changes and modifications of the program that may not have been known at the start of the contract (Christensen, Searle, and Vickery, 1999:253).

**Interested Parties**

Cost growth in the various DoD programs is a problem that concerns not only the people that work in the acquisition environment but also the members of the U.S. Congress, the defense industry, and certainly the U.S. public (Calcutt, 1993: i).

**a. The Department of Defense**

"The DoD is responsible for providing the military forces needed to deter war and protect the security of the U.S." (DoD Directive 5100.1). Cost growth reduces the ability of the DoD to procure and provide the number and type of weapons necessary to equip the military forces, in order to meet their mission requirements. Furthermore, the radical changes in the U.S. military after the end of the Cold War contributed to the reduction in defense spending. According to Grasso, the DoD procurement spending has declined by 59% from 1987 to 1997 (Congressional Research Service Report, 2002): CRS-2). Figure 2 provides a graphical representation of the percent change of the DoD Budget and the DoD cost overruns over time. In order for the DoD to continue providing the military forces with the same level of modernization, changes to the acquisition and procurement process are required (Holbrook, 2003:2). The issues associated with tight defense budgets, and the existence of cost growth in most of the DoD programs creates an environment full of challenges in which the DoD tries to provide the best services to the military forces.

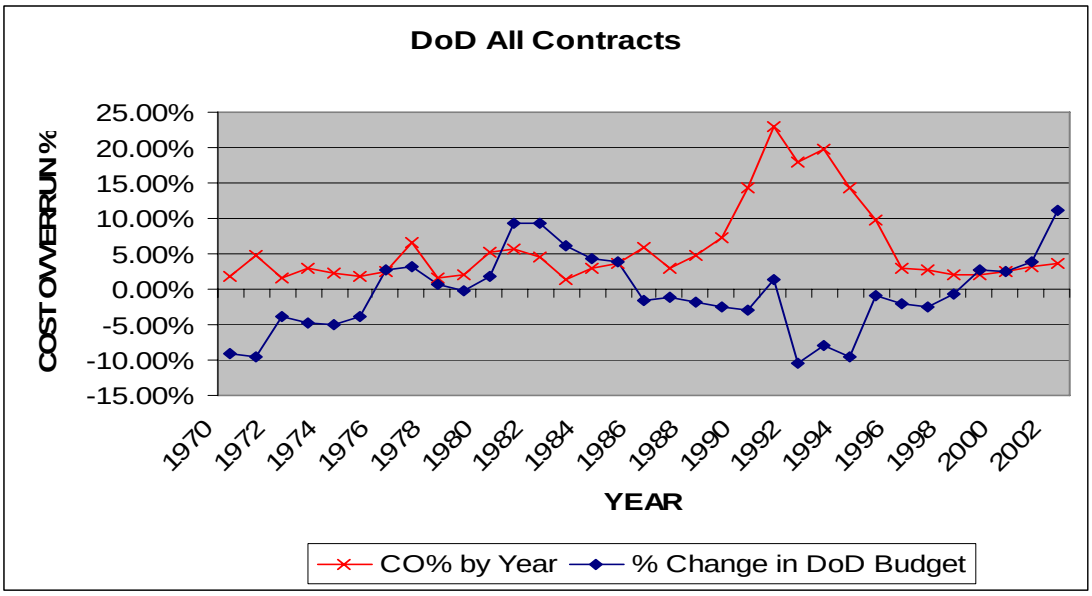



**Figure 2: DoD Cost Overruns and Percent Change of DoD Budget**

**b. The Defense Industrial Base (DIB)**

The DIB may also be affected by cost growth. The DIB consists of firms that supply the DoD with the necessary equipment in order to accomplish their mission, sectors of industry, and industrial assets that are used to manufacture products mostly for military purposes (Sandler and Hartley, 1995: 182). The existence of DIB in a country provides a number of benefits, as well as costs to the country that maintain this industrial base. A number of these benefits are listed below:

a. National independence, self sufficiency and responsiveness in emergencies and war are considered to be major benefits for a country that has a defense industrial base. The country doesn't depend on potentially unreliable foreign suppliers of defense equipment, especially in a crisis situation or a conflict. Nevertheless, these benefits also include some costs to the country, since some of the unreliable foreign suppliers might be members of a military alliance. Alliance members can provide their experience and the

potential of defense equipment standardization, thereby reducing the costs for research and development of costly defense equipment. As we can see, sometimes the preservation of defense independence can be very costly.

b. The need to maintain a capability which a nation believes will be required in the future. Many believe that the importation of high technology defense equipment may cause a nation to lose the capability to produce high technology weapon systems in the future. They fear that it will be both costly and time consuming.

c. Foreign supply leaves the buyer vulnerable to monopoly price increases. The buyer nation can be locked in buying spare parts and support for a cheap initial acquisition cost, while sustained costs reach near sustained monopoly prices. The life cycle cost of the program could very well be higher than the domestic alternative, although, the same concept can be debated for domestic alternatives.

d. Leverage. A strong defense industrial base can provide the necessary knowledge to increase the bargaining power. Nevertheless this argument cannot justify the existence of a very big and costly defense industrial base because the same leverage can be achieved by a small core of R&D establishments owned by the private sector, or possibly even by the government. Furthermore, the bargaining power of a nation can be increased when there is competition in the world market of defense equipment.

e. A defense industrial base provides national benefits. A healthy DIB can provide jobs, contributing to the reduction of unemployment. The high technology sectors of the defense industry work as key factors for improving the international competitiveness of the economy. It is believed that a strong DIB can be used as the

leading sector providing spin – off benefits to the rest of the economy. On the other hand, there are a lot of alternatives that can provide the same or more benefits with less cost. In this case, a DIB may direct resources away from investments that provide more growth in the economy. For example, the construction of a hospital may provide jobs and other social benefits.

These are some of the benefits and costs for a nation in order to have a DIB (Sandler and Hartley, 1995: 182). Nevertheless the DIB of the United States and other nations has shrunk over the past several years. The quantities of the various weapons systems produced have been reduced as a result of budget limitations and the growth in the unit production costs. Many companies have merged, creating a stronger company, or have reoriented to produce different products (Searle, 1997:14). Cost growth negatively contributes to the ongoing debate of whether or not to maintain a defense industrial base within a country. The big question is how much are the countries willing to pay in order to preserve the benefits of a strong and healthy DIB? Cost growth will play a significant role in the decisions to be made, in order to decide the future of the DIB.

**c. United States (U.S.) Congress**

According to the U.S. Constitution:

> All legislative powers herein granted shall be vested in a Congress of the U.S., which shall consist of a Senate and House of Representatives. The Congress shall have the power to lay and collect taxes, duties, imposts and excises, to pay the debts and provide for the common defense and general welfare of the U.S., to make rules for the government and regulation of the land and naval forces; but all duties, imposts and excises shall be uniform throughout the U.S. (U.S. Constitution Article 1 Section 1 and 8).

One of the duties of the Congress, according to the U.S. Constitution, is to oversee the national defense program and by proxy, oversee the acquisition of weapon systems. Congress, through the General Accountability Office (GAO), congressional hearings and the Congressional Budget Office (CBO), tries to examine some aspects of cost growth (Calcutt, 1993:14). Congress is the manager who is responsible to direct resources in order to achieve a stated goal. The goal of Congress is to provide the citizens of this country with all the necessary public goods. National and domestic security, national defense, public health and welfare programs, a clean environment, and education are some examples of public goods. The limited resources available make the task of Congress to allocate resources very difficult. Cost growth in the defense programs consumes unnecessarily large amounts of scarce resources that could be used in order to produce other public goods.

**d. United States (U.S.) Public.**

Defense is a public good, for which the government is responsible for its provision to the people of a country. The government, in order to finance the procurement of public goods, has to tax its citizens. The government, through the procurement of public goods and services and the taxes that apply to the public, decide how to allocate the scarce resources of the government. The government decides the magnitude and the distribution of the procured public goods or services (Begg, Fischer, & Dornbusch, 1994). Cost growth in the various defense programs either increases the total dollars that should be allocated for defense or reduces funding for other programs of the DoD. These extra dollars are received either through bigger taxes for the public or through

reallocating the dollars spend for procuring other public goods or services. Either way the public is not satisfied. The public is willing to sacrifice a portion of the national output for national defense but certainly not so willing to trade other public goods like health and education in order to support programs that experience cost overruns.

**Factors responsible for cost growth**

Over the years, many factors (see Table 1) have been identified as responsible for cost growth in major procurement programs of the DoD (Calcutt, 1993:14), such as:

1. Planning Difficulties - The factors represented in this category, are those that tend to prevent realistic and early estimation of the final cost of a program (Searle, 1997:18).

2. Risk Elements - The factors represented in this category, are those that are more inherent to the system. These factors are neither controllable nor predictable (Searle, 1997:19).

3. Management Inefficiencies - The factors represented in this category, are those that are considered as controllable by the management (Searle, 1997:19).

Calcutt identified similar factors as we can see in Table 2 (Calcutt, 1993:16).

**Table 1. Factors Affecting Cost Growth (Searle, 1999)**

| Planning Difficulties | Risk Elements | Management Inefficiencies |
|---|---|---|
| 1) Incomplete Definition of Work | 6) Unforeseeable Conditions | 11) Disorganized Work Direction and Productivity |
| 2) Interface Incompatibilities | 7) Unpredictable Regulatory Funding delays | 12) Subcontracting |
| 3) Changes; Failure to Anticipate Needs. | 8) Unforeseen Technical Difficulties | 13) Unnecessary Work or "Gold Plating" |
| 4) Estimating Uncertainties; Poor Estimating | 9) Uncontrollable Forces | 14) Project Control |
| 5) Optimistic Assumptions | 10) Unanticipated Economic Conditions | 15) Work Load Projections |

**Table 2. Factors Attributed to Cost Growth (Calcutt, 1993:17)**

Requirements Definition
- ✓ Poor initial requirement definition
- ✓ Poor performance/cost trade-offs during development
- ✓ Changes in quantity requirements

Cost Estimating
- ✓ Errors due to limitations of cost estimating procedures
- ✓ Failure to understand and account for technical risks
- ✓ Poor inflation estimates
- ✓ Top down pressure to reduce estimates
- ✓ Lack of valid independent cost estimates

Program Management
- ✓ Lack of program management expertise
- ✓ Mismanagement/human error
- ✓ Over optimism
- ✓ Schedule concurrency
- ✓ Program stretch outs to keep production lines open

Contracting
- ✓ Lack of competition
- ✓ Contractor buy-in
- ✓ Use of wrong type of contract
- ✓ Inconsistent contract management/administrative procedures
- ✓ Too much contractor oversight and reporting requirements
- ✓ Waste
- ✓ Excess profits
- ✓ Contractors over staffed
- ✓ Contractor indirect costs unreasonable
- ✓ Taking too long to resolve undefinitized contracts

Budgetary
- ✓ Funding instabilities within DoD caused by trying to fund too many programs
- ✓ Funding instabilities caused by congressional decisions
- ✓ Inefficient production rates due to stretching out programs
- ✓ Defense Acquisition Board (DAB) - - formerly DSARC - -out of synchronization with the services' Program Objective Memorandum (POM) cycle
- ✓ Failure to fund for management reserve
- ✓ Failure to fund programs at most likely cost

In addition to the above mentioned factors, cost growth is influenced by the political nature of the defense acquisition process, especially as it relates to the role of Congress in overseeing and managing the budgetary and acquisition processes. Templin, Gansler and Fox (1988) point out those political factors can cause program instability, cost growth, and overregulation leading to inefficiency and waste (Templin et al. 1992:3).

**Actions taken to control Cost Growth**

Many actions have been taken by the DoD over the years, such as acquisition reforms and other initiatives, in order to improve the acquisition process and confine or even eliminate cost growth from the various procurement programs. Table 3 consolidates some of the acquisition reforms and initiatives that took place over the years in accordance with Searle (1997:29-30) and Skofield (2004:19).

**Table 3. Acquisition Reforms and Initiatives (Searle, 1999 & Skofield, 2003)**

| Year | Regulations/initiatives |
|---|---|
| 1969 | Packard Initiatives Published |
| 1971 | Blue Ribbon Defense Panel (Fitzhugh Commission) |
| 1972 | DoDD 5000.1 (Major Systems Acquisitions); Commission on Govt Procurement |
| 1973 | DoDD 5000.4 (CAIG); DoDD 5000.3 (T&E) |
| 1975 | DoDD 5000.2 (Major Systems Acquisitions); DoDD 5000.28 (DTC) |
| 1976 | OMB Circular A-109 |
| 1978 | Defense Science Board Acquisition Cycle task Force |
| 1979 | Defense Resource Management Study |
| 1981 | Carlucci Initiatives (AIP); Defense Acquisition Improvement Program |
| 1982 | Nunn-McCurdy (thresholds) |
| 1983 | Office of Federal Procurement Policy Act; Grace Commission |
| 1984 | DoD Authorization Act (Public Law 98-94) created Office of Operational Test & Evaluation |
| 1984 | Competition in Contracting Act (CICA) |
| 1985 | DoD Procurement Reform Act; DoD 5000.43 (streamlining) |
| 1986 | Packard Commission; Goldwater-Nichols DoD Reorganization Act, Defense Procurement Improvement Act, Defense Acquisition Improvement Act |
| 1987 | DoDD 5134.1 (Undersecretary of Defense Acquisition)(USD(A)); DoDD 5000.49 Defense Acquisition Board (DAB) |
| 1989 | Defense Management Review. Ethics Reform Act |
| 1990 | Defense Acquisition Workforce Improvement Act |
| 1991 | Revised DoDI 5000.2 (Major System Acquisitions). Section 800 Panel created by 1991 National Defense Authorization Act (Public Law 101-510) |
| 1994 | Defense Acquisition Reform. Federal Acquisition Streamlining Act (FASA) |
| 1995 | FASA II,Air force Lighting Bolts 1 |
| 1996 | Federal Acquisition Reform Act. Clinger-Cohen Act. Rewrite DoD 5000 Series |
| 1999 | Air force Lighting Bolts 2 |
| 2000 | Revised DoD 5000 Series |
| 2002 | Agile Acquisition Initiatives (Airforce Lightning Bolts 3 |
| 2003 | Rewrite Dod 5000 Series |

The results of these initiatives were that DoD took some measures (see Table 4) in order to constrain the factors responsible for cost growth (Calcutt, 1993: 23).

**Table 4. Initiatives to Combat Cost Growth (Calcutt, 1993)**

Requirement Definition
- ✓ Strategies-to-task approach for identifying requirements
- ✓ COEAs required at Milestones II, III, and IV

Program Management
- ✓ Established required training for program managers
- ✓ Established the professional acquisition corps
- ✓ Required adequate front and funding for test hardware
- ✓ Established DSARC (later DAB) for program oversight
- ✓ Increased program manager's authority
- ✓ Established Value Engineering policy

Cost Estimating
- ✓ Established Cost Analysis Improvement Group (CAIG)
- ✓ Established approved inflation factors
- ✓ Stressed need for prototyping to gain greater insight into risks and costs
- ✓ Established Preplanned Product Improvement (P3I) policy to reduce program risks
- ✓ Established program base lining requirement
- ✓ Established Should cost reviews

Contracting
- ✓ Improved source selection procedures to prevent "buy-in"
- ✓ Stressed use of appropriate type contract
- ✓ Established procedure to obtain better estimate of contractor's overhead
- ✓ Instituted CICA
- ✓ Implemented acquisition streamlining
- ✓ Eliminated firm fixed price contracts for major development efforts

Budgetary
- ✓ Directed services to fully fund programs to protect schedule
- ✓ Instituted milestone budgeting (Defense Enterprise program)
- ✓ Directed programs to budget for technical risk
- ✓ Directed programs to budget to most likely cost
- ✓ Implemented Multi-year Procurement (MYP)
- ✓ Directed use of economic production rates

A study conducted by RAND over fiscal years 2003-2004, provides information about the acquisition reform initiatives. For this study, 63 distinct acquisition reforms (AR) initiatives undertaken from1989 to 2002, were used, as shown in Figure 3.

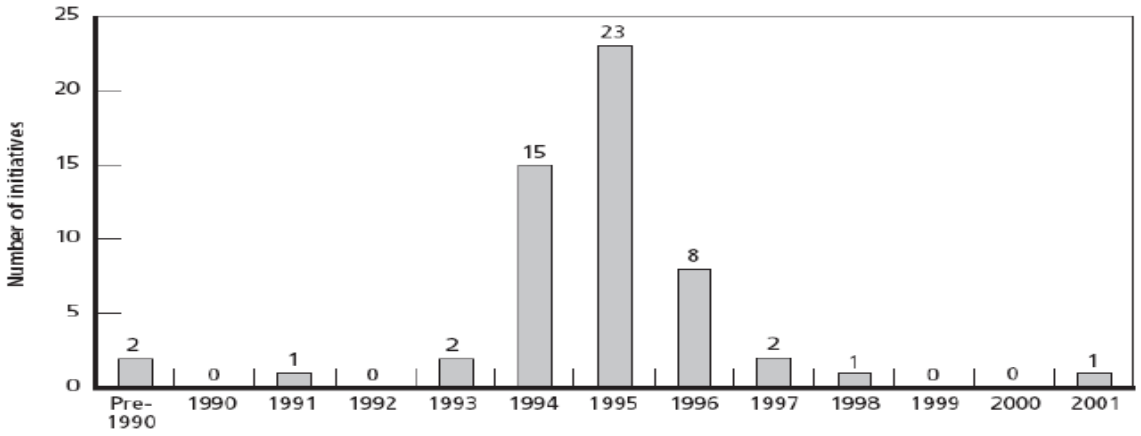



**Figure 3. Chronology of Acquisition Reform Initiatives (RAND 2005)**

Furthermore, the study examined the relationship of these initiatives to acquisition functions and grouped the initiatives by type as we can see in Figures 4 and 5.

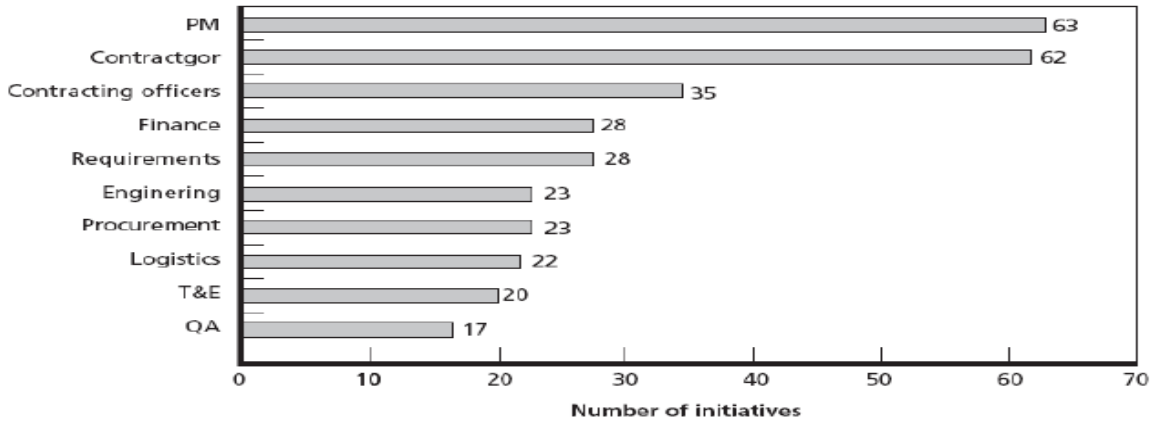



**Figure 4. Acquisition Reform Initiatives in Relation to Functions Affected (RAND 2005)**

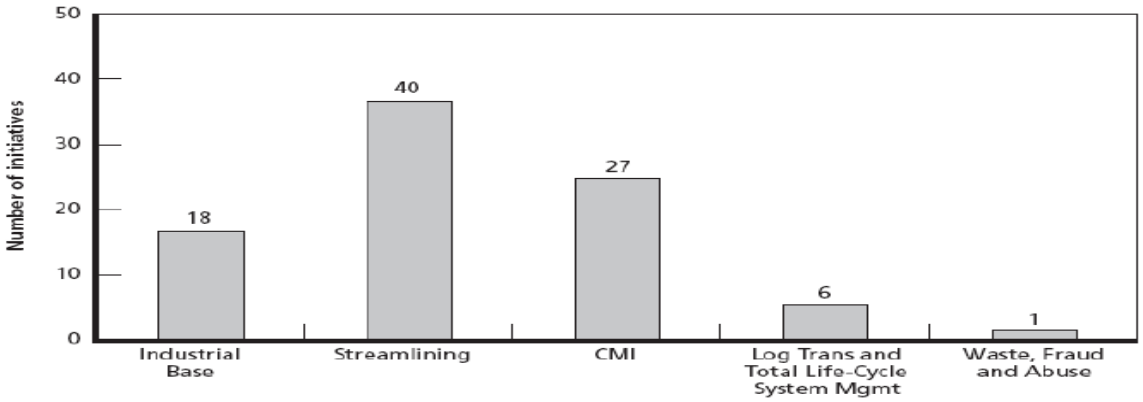



**Figure 5. Acquisition Reform Initiatives Grouped by Theme (RAND, 2005)**

Finally, the RAND study examined whether the initiatives were referenced to the DoD 5000 Series acquisition policy by type, as shown in Figure 6.

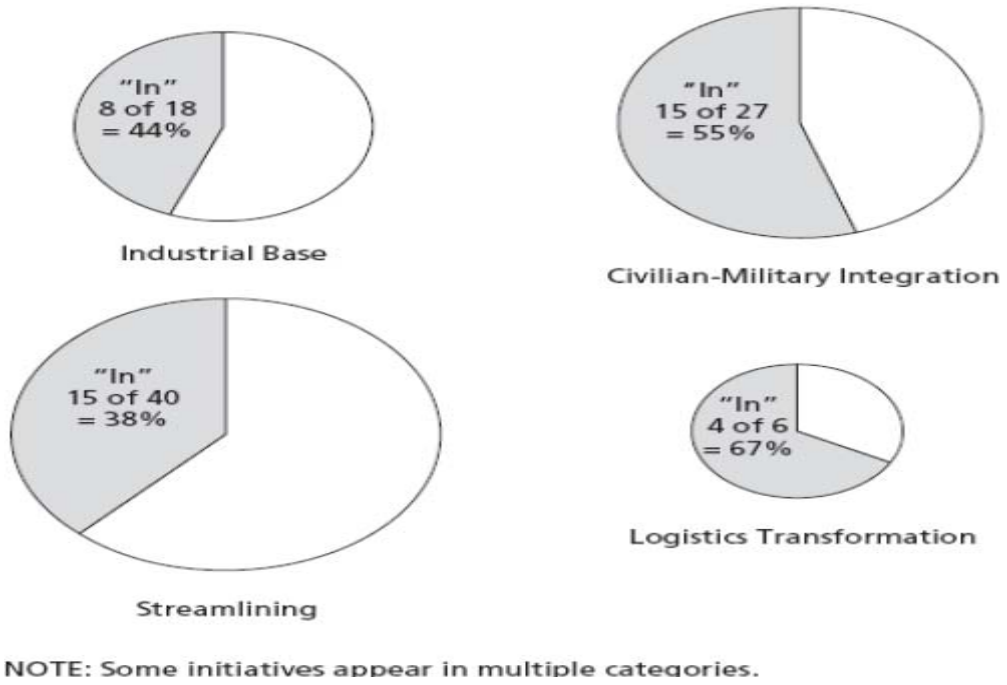



**Figure 6. Inclusion of Acquisition Reform Initiatives in DoD 5000 Series According to Theme (RAND, 2005)**

This study concludes that some good has come from some acquisition reforms and initiatives, but there remain serious structural and cultural obstacles that delay the

ability of the acquisition process to deliver desired outcomes in terms of cost, schedule, and performance (RAND, 2005:45). However all these initiatives, acquisition reforms, and the actions or measures resulted by them, have provided the defense community with a number of weapons to fight cost growth.

**Involvement of Congress**

The constitutional role of Congress is to provide adequate funds for defense. Their top priority is to ensure that the armed forces receive the best equipment in order to accomplish their mission. Congress performs its legislative duties through the House of Representatives and the Senate. Both houses consist of various committees. Perhaps the most important phase of the legislative process is the action by their respective committees. Virtually all legislation is referred to a committee. This give each committee tremendous importance, as they set the tone for future legislation. The bills that go to the full House of Representatives and to the Senate for approval have been shaped by the committees. The committees examine very carefully each measure proposed and also provide a forum where the public has the opportunity to be heard. It is well-known that the committee system has played a crucial role in the maintenance of the power of the Congress. The parliamentary system of the U.S. is built on the investigations conducted by the committees. (Goodwin, 1970: ix and 108$^{th}$ Congress 1$^{st}$ Session, 2003: 9).

The House of Representatives and the Senate each have, at present, 19 and 16 standing committees, respectively. Each committee's jurisdiction is divided into certain themes under the rules of the House of Representatives and the Senate. Each committee examines the measures that affect a particular area of the law with respect to the

jurisdiction given over that particular area. The committees consist of members of Congress elected by the two major political parties. The majority party determines the proportion of the members of the minority party to the members of the majority one. The chairman of the committee is elected by the majority party and usually is the member with the most continuous service. Committees evaluate a measure and report the results of the evaluation and the proposal of the committee through the Committee reports (Figure 7). These reports are very important because they are used by the courts, the public, and all the interested parties as sources of information in order to understand the purpose and the meaning of the law (108th Congress 1st Session, 2003: 9).

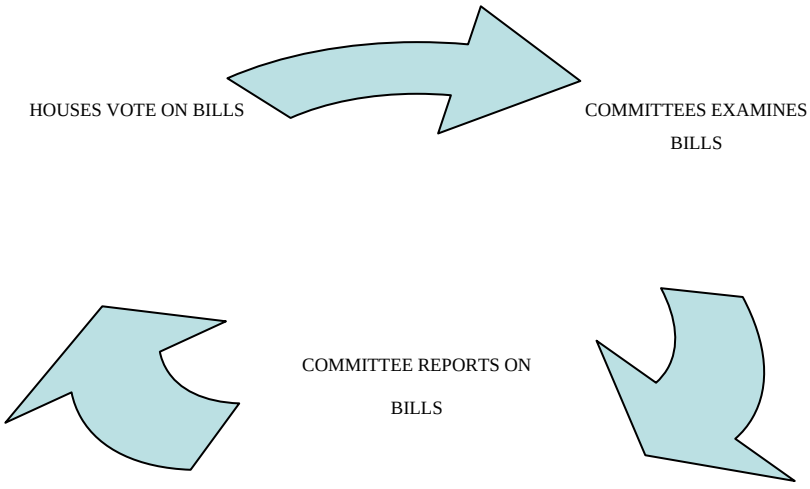



**Figure 7. Legislation Procedure**

This thesis is interested in two of the Congressional committees. The Armed Services Committees of the House of Representatives and the Senate are responsible for overseeing all aspects of national security policy, including the annual $340 billion defense appropriation.

During the last fifty years, Congress has increased the oversight of the various defense programs because “The U.S. national defense program is very expensive and notoriously plagued by waste, fraud, and mismanagement” (Higgs, 1988:79). A growing literature suggests that Congress has become too active in overseeing the DoD (Mayer, 1993:294). Congress exercises its constitutional rights by reviewing the budget by line item or by individual program, discussing whether to fund one program instead of another, or whether a particular program should be funded at all. Furthermore, Congress oversees defense programs and takes appropriate actions in order to eliminate or contain problems, such as cost growth in the various defense programs (Higgs, 1988:79). Unfortunately, the reason for this level of Congressional attention is not necessarily indicative of their willingness to govern cost growth, but may be a way of reviewing defense programs to help promote their own electoral prospects (Mayer, 1993:297). According to Higgs (1988:79) Stein pointed out that “The root of Congressional misfeasance is that hardly anyone [in Congress] feels a primary responsibility for the defense program as the safeguard of our national security. Too many are able to look upon the defense budget as a big pot of money from which they can serve their special interests.” Most people will agree with the statement of Rep. James Counter (R-N.J.), as presented by Higgs (1988:79), who said, “Congress is not the answer to waste. Congress is the problem”. According to Mayer (1993:297), the Office of the Secretary of Defense (OSD) pointed out that: “Members are accused of attacking the Pentagon to create publicity, or even to achieve influence within Congress. DOD argues that the pork barrel

incentive drives many congressional interventions, as members use their power over the budget to deliver programs and contracts to constituents".

**Voting Behavior of the members of the U.S. Congress**

The members of Congress have to make difficult decisions in a very uncertain environment. Every day they have to make decisions on a wide range of issues. These decisions legitimize the distribution of certain advantages and disadvantages to various groups of people. Given that some groups will be favored by the decision while others are not, we expect different reactions from the various groups of people. Pressure on the members of Congress will be exercised by the potentially affected groups in order to maximize the benefits or minimize the losses from each decision. Bottom line, when a member of Congress votes for a bill, they generally suffer from the following five types of pressure (Froman, 1964:3 and Kingdon, 1989):

i. Constituency pressure - which includes the congressman's district voters, either individual or interest groups.

ii. Party pressures - Many times the leader of the party or other party members make a public stand on an issue and expect support from fellow party members. This public stand may serve as a constraint on voting behavior.

iii. Institutional pressures - which include those from his colleagues, his friends, party leaders, committee chairmen.

iv. Executive pressures – Pressures from the various agencies of the government.

v. Personal pressures – this involves the personal values, the beliefs, the preferences and attitudes of the Congressman.

According to King and Zeckhauser (1999:3) the legislators, when deciding how to vote, should be worried about their personal values, the views of their constituents, and the preferences of their financial supporters.

Members of Congress have a job for which they worked very hard to earn and most of them want to keep it. All members of Congress, with a few exceptions, are interested in contributing to good public policy. They want to help their fellow citizens, but most of all, they want to help their country and create policy for the common good. Nevertheless the legislators, especially first term Congressmen, care also about making a good impression on the party leaders or the committee chairmen in order to gain better assignments and more political power. They care about avoiding big mistakes that will influence their political career. They care about getting seniority and the power that comes with it. The members of Congress care about long run policy outcomes. Each vote they cast has an impact on their political career. The vote is the tool that will help reelect each of the members of Congress, which may be their true ultimate goal (Higgs 1988:80, and King and Zeckhauser, 1999:6).

In order to be reelected, incumbents must be worry about the opinions of the people they represent. Typically, if constituents enjoy high employment, then they will be happy and the majority of voters will be pleased with the performance of their Congressman. The voters of the various districts and states are realistic. They are interested only in what their representative has done for them, and in Senator Alben

Barkley's immortal words, "What have you done for me lately?" Many studies on public opinion show that voters want their political representatives to "bring home the bacon" (Higgs 1988:80-81). Morris Fiorina pointed out that:

> Each of us wishes to receive a maximum of benefits from government for the minimum cost. This goal suggests maximum government efficiency, on the one hand, but it also suggests mutual exploitation on the other. Each of us favors an arrangement in which our fellow citizens pay for our benefits (Higgs 1988:81).

The members of Congress, having in mind the preferences of their financial supporters and the views of their constituents, try to satisfy their voters by:

> establishing plausible claims to have channeled benefits toward and costs away from their constituents. Constituents and financial supporters value federal contracts and subsidies to local businesses; grants to local governments, schools, training programs, and sanitation facilities; federally funded dams and irrigation works; targeted loans and loan guarantees; military bases; and interstate highways and other construction projects in the district (Higgs 1988:81).

Rep. Pat Schroeder (D-Colo.) stated in the early 1980s that: "If you want anything for your district…. the only place there is any money at all is in the Armed services Committee bill" (Higgs 1988:86). From Word War II until 1988, U.S. spent more than $6,600 billion (in 1982 dollars) for national defense. The members of Congress for several decades have identified the opportunity for the potential use of the budget for their own purposes and have been alert to seize the opportunity sometimes in very ingenious ways (Higgs 1988:86).

Senator Diane Feinstein (D-CA) said that:

> This plane (referring to the B2) is capable of taking off from Whiteman Air Force Base with two people aboard, being refueled once in midair, striking anywhere in the world and returning home safely, with very few people in harm's way and with very little commitment. And it can deliver a large payroll (Congressional Floor Debate, June 30, 1994.)

Ira Shorr, Senior Producer and Narrator of America's Defense Monitor program, commenting on Senator Feinstein's speech, said:

> The distinguished Senator from California undoubtedly meant to say "payload," but "payroll" was really on her mind during a debate on whether to spend $150 million in 1995 to preserve the ability to keep making the B-2 bomber. Many in Congress could have made the same slip; for many now value the defense industry more for the jobs it provides than the weapons it builds for our military forces (America's Defense Monitor, 1994).

On the same program Mr. McNaugher said:

> I think there are plenty of times when the Services really don't want something that the Congress will force them to buy. I mean, the Air Force has been buying 6 to 12 C-130s a year forever because it's built in Georgia and the Georgia contingent puts it in. And, you know, in a tight budget environment that means something else has to come out (America's Defense Monitor, 1994).

It is very clear that the residents of the United States should have a national defense versus a defense that is driven by the personal interests of a district in California or the state of Idaho. The members of Congress should concentrate on providing national defense to the whole nation and not to their constituents and the various interest groups that pressure them in order to maximize the benefits from the legislative process. Unfortunately, as Higgs pointed out:

> Yet no one in the Congress has much incentive to promote the national defense. In fact, all members face incentives and constraints that push them toward support of measures that weaken the national defense by depleting the defense budget to finance particularistic benefits that do nothing to produce genuine national security. Worst of all, selling out the national defense apparently violates no political norm, at least no congressional norm (Higgs, 1988: 85).

**Past Research**

Many studies have been conducted over the last years on cost growth. This section will cover some of these studies.

a. **Singleton Study (1991)**: The scope of the Singleton study was to investigate the factors that cause cost growth in major and non major weapon systems that were initiated by the Aeronautical Systems Division from 1980 to 1988. Singleton used the literature review and the expert opinions of five cost analysts in order to come up with a list of factors affecting cost growth. The study identified three major cost drivers: advance technology, design stability, schedule risk. Singleton, use 16 programs to test the existence of correlation between cost growth and the three factors she identified, concluded that to minimize cost growth in the development effort, system requirements should be stabilized as early as possible, since programs with low design stability tend to experience bigger cost growth regardless of the behavior of the other two factors. On the other hand, during production both design and schedule stability significantly influence cost growth (Singleton, 1991). The results of this study may not be generalized because of the small sample of programs that she used but the information received through the literature review she used may be useful to better understand other research variables of interest.

b. **Searle Study (1997):** This study examined the impact of the Packard Committee (1991) initiatives on reducing cost overruns in major DoD programs. For his research, Searle used data from 1988 to 1995 contained in the DAES database. In order to measure cost growth, Searle used the cost overrun concept. Because this measure fails to consider

contract size and inflation, Searle calculate the final overrun percentage (FO %) to control for contract size and inflation. In order to calculate the relative measure of cost performance, he used the following formula:

$$FO\ \% = \frac{Overuun_{Final}}{BAC_{Final}} \quad (3)$$

Where: $Overrun_{Final} = BAC_{Final} - ACWP$ (4)

For his research, Searle used the mean FO% of the programs for each year as his research variable.

The results of Searle's study show that the recommendations made by the Packard Commission may have been ineffective in reducing cost overruns in major acquisition programs and may have actually led to a poorer cost performance. Furthermore the literature identified a number of factors that affect cost growth (Searle 1997). The methodology used by Searle motivates this research. Searle's study helped to identify the research variable and to acquire sufficient information on the research involving cost growth. Some of the factors identified by Searle that affect cost may be used in this research as control variables in building a predictive regression model.

c. **Sipple Study (2002):** This study explored the utility of logistic regression in finding predictors of engineering cost growth for the Engineering Manufacturing Development (EMD) phase of acquisition, using data from the Selected Acquisition Reports (SAR). Sipple's research and his extended literature review helped this research understand cost growth and the search for explanations of cost growth.

d. **Holbrook Study (2003):** This study examined the impact of acquisition reform initiatives implemented since 1993 on contract cost performance. Furthermore, it examined trends or time lags between reform implementation and contract cost performance change. In order to conduct his research, Searle used data for the first part from 1994 to 2001 and for the second part from 1970 to 2002, all from the DAES database. Holbrook used the same research variable as Searle did in his study. In order to conduct his trend analysis, Holbrook used the mean cost overrun percentage of the programs which is defined as the average cost overrun over the average amount of work completed (mean BCWP). The averaging of the cost overruns for each of the year helps to smooth out any monthly spikes caused by the inconsistent reporting contained in the DAES database (Holbrook, 2003:49).

The research showed that acquisition reforms had no impact on cost growth. For the second part of the research the results indicated some evidence of cost performance change following the different studies and commissions as shown in Figure 8. Holbrook's literature review provided valuable information about cost growth and a thorough explanation of DAES database. The methodology and the data used by Holbrook and by Searle motivate this research and help to identify the research variable in order to build a predictive regression model.

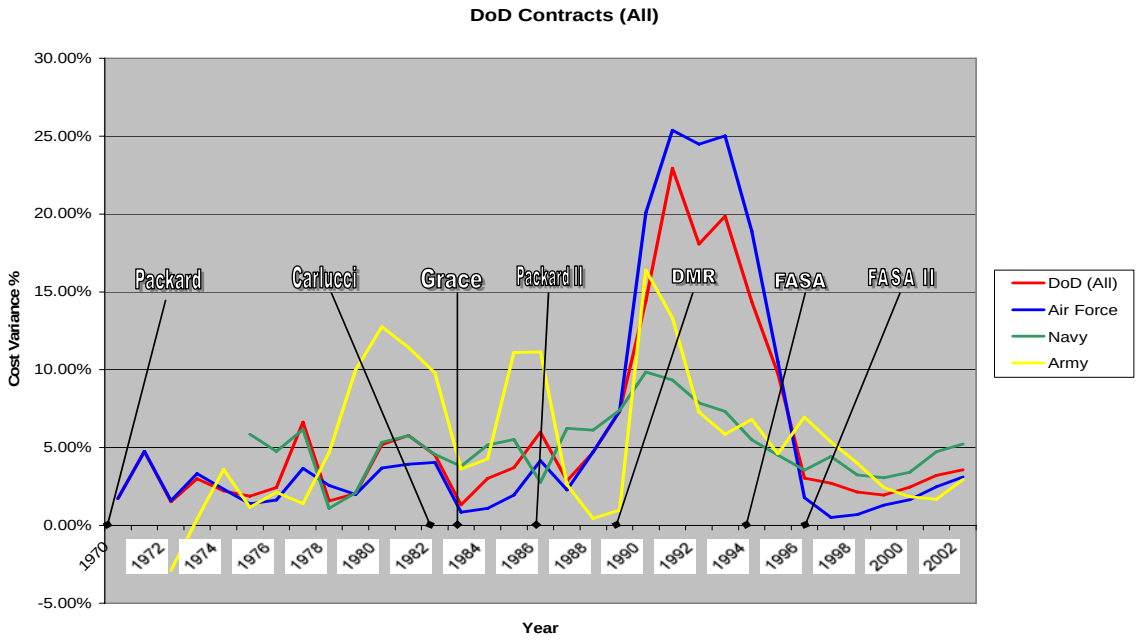



**Figure 8. Trend vs Timeline Chart (Holbrook, 2003)**

**e.** **<u>Outsourcing the Pentagon. Who benefits from the Politics and Economics of National Security by Larry Makinson (2004):</u>** This study examines the role of contractors in the American military. It examines the practice of awarding no bid contracts to well connected companies of the defense industry. In order to conduct his research, Makinson and the Center for Public Integrity used data from the Pentagon's procurement database. They examined more than 2.2 million contracts, totaling $900 billion, from fiscal year 1988 to fiscal year 2003. The results of this study are:

i. About half of the DoD budget goes to private contractors. There are 737 contractors that collected at least $100 million in prime contracts from 1998 to 2003. These companies collected almost 80% of the defense budget procurement dollars. There are 50 companies that received more than half of the money and 10 companies that

collected 38%. The company that collected the biggest amount is Lockheed Martin with $94 billion over the six year period. Figure 9 provides a graphical representation of the 20 biggest defense contractors and Figure 10 compares the dollars received by the five biggest contractors with, the total of the defense contracting dollars, all the defense spending, and finally with the discretionary spending of the entire federal government.

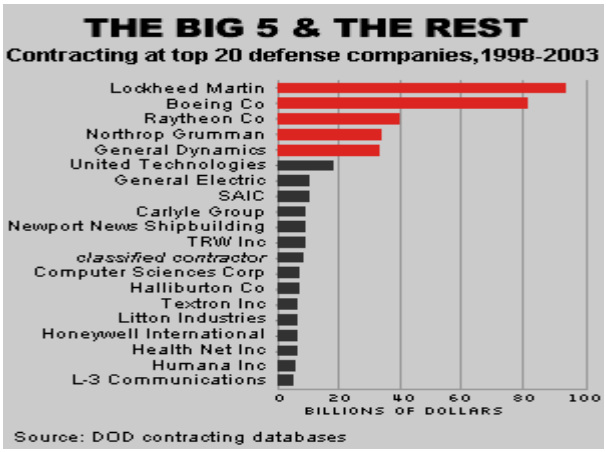



**Figure 9. The 20 Biggest Defense Contractors (Makinson 2004).**

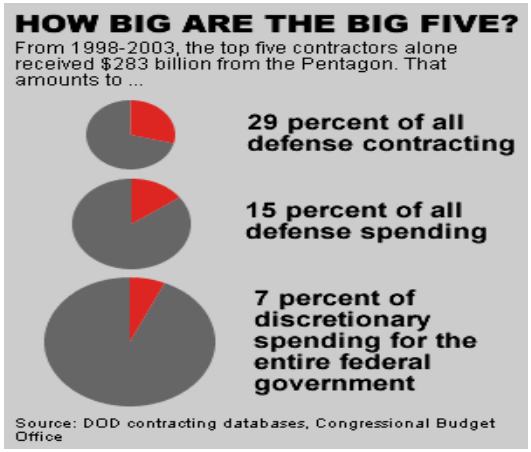



**Figure 10. Define the magnitude of the 5 Biggest Defense Contractors (Makinson 2004).**

**ii.** The biggest defense contractors won their contracts without going through the competitive process. Only one company of the 10 biggest defenses contractors won more than half of its dollars through an open bidding process. This company was Science Applications International Corp. (SAIC). Table 5 provides details on how the 20 biggest contractors won their contracts from 1998 to 2003. Only 40% of the total contracts have been awarded through the natural competitive process (sealed bids, competitive proposals, or a combination of both).

**Table 5. Competition for the defense contracts (Makinson 2004).**

| Name | Total Contracts | Full & Open | Not Full & Open | Other | No Info |
|---|---|---|---|---|---|
| Lockheed Martin | $94,056,641,059 | 25% | 74% | 1% | 0% |
| Boeing Co | $81,645,655,400 | 40% | 60% | 0% | 0% |
| Raytheon Co | $39,904,717,897 | 31% | 67% | 1% | 1% |
| Northrop Grumman | $33,829,847,656 | 33% | 59% | 2% | 6% |
| General Dynamics | $33,280,959,821 | 30% | 69% | 0% | 0% |
| United Technologies | $17,953,516,117 | 3% | 95% | 2% | 0% |
| General Electric | $10,600,007,101 | 9% | 88% | 1% | 2% |
| Science Applications Intl Corp (SAIC) | $10,598,835,883 | 74% | 6% | 7% | 12% |
| Carlyle Group | $9,334,962,462 | 38% | 60% | 0% | 2% |
| Newport News Shipbuilding | $8,852,781,214 | 2% | 98% | 0% | 0% |
| TRW Inc | $8,725,744,602 | 70% | 24% | 2% | 3% |
| CLASSIFIED CONTRACTOR | $8,267,851,367 | 16% | 82% | 0% | 2% |
| Computer Sciences Corp | $6,789,832,719 | 75% | 10% | 1% | 13% |
| Halliburton Co | $6,768,728,331 | 65% | 34% | 1% | 0% |
| Textron Inc | $6,629,835,387 | 5% | 95% | 0% | 0% |
| Litton Industries | $6,478,824,475 | 38% | 56% | 1% | 6% |
| Honeywell International | $6,135,622,361 | 31% | 62% | 4% | 3% |
| Health Net Inc | $6,111,054,478 | 99% | 0% | 1% | 0% |
| Humana Inc | $5,683,896,585 | 87% | 13% | 0% | 0% |
| L-3 Communications | $5,233,392,435 | 34% | 54% | 4% | 8% |
| NOTE: Totals in this and all other charts naming defense contractors include both the corporate parent and their subsidiaries and affiliates. | | | | | |

Figure's 11 and 12 provide a graphical representation of the biggest defense contractors and the competitive process that was followed in order to be awarded with the various defense contracts for the examined period.

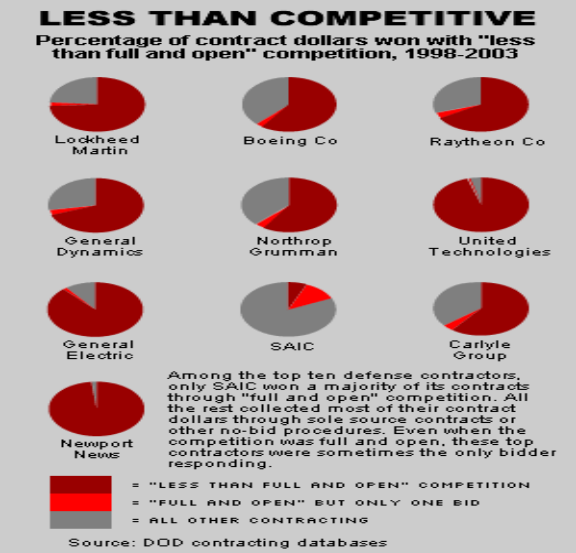



**Figure 11. Competitive process followed for the 10 biggest defense contractors (Makinson 2004).**

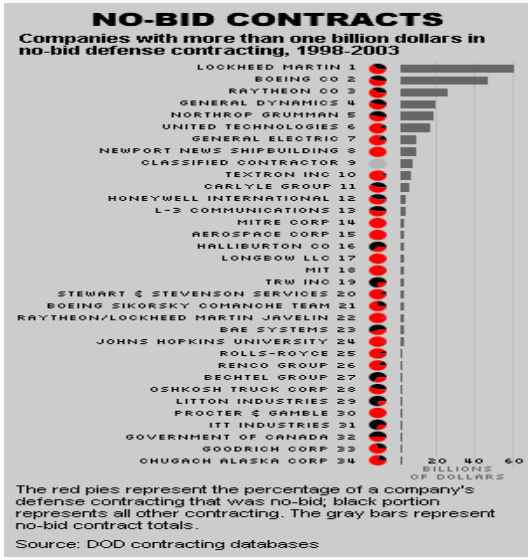



**Figure 12. No Bid Contracts (Makinson 2004)**

Most of the contracts were awarded without any competition and the reason was that only one source existed for the requested product or service from the DoD (see Figure 13).

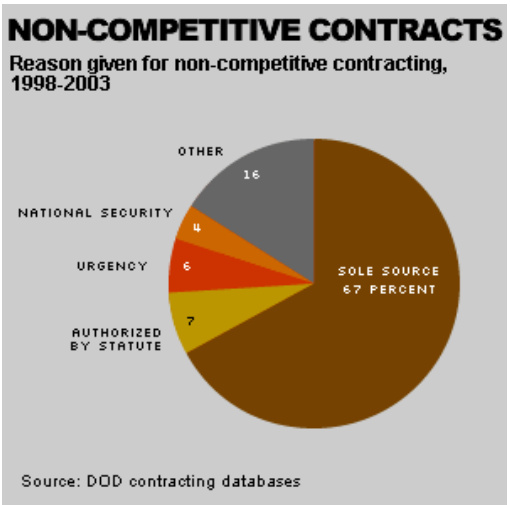



**Figure 13. Reasons for non competitive contracting, 1998-2003 (Makinson 2004)**

Furthermore this study recognizes that different categories of products and services have different levels of competition as we can see in Table 6.

**Table 6. Least and Most Competitive Categories (Makinson, 2004)**

| Least Competitive Categories | Total | Less than Full & Open Competition |
|---|---|---|
| Guided Missiles | $22,747,653,356 | 96% |
| Fire Control Equipment | $4,121,932,856 | 87% |
| Engines, Turbines and Components | $23,254,881,284 | 85% |
| Aircraft Components and Accessories | $14,875,527,520 | 84% |
| Trucks, Trailers, Ground Assault & Other Motor Vehicles | $14,892,149,100 | 80% |
| Ships, Small Craft, Pontoons and Floating Docks | $31,231,838,029 | 80% |
| Weapons | $7,484,413,528 | 79% |
| Quality Control, Testing and Inspection Services | $4,398,926,543 | 78% |
| Aircraft and Airframe Structural Components | $86,530,378,638 | 77% |
| Engine Accessories | $2,518,265,449 | 75% |
| Lease or Rental of Facilities | $2,668,382,442 | 74% |
| Miscellaneous Products | $10,542,274,617 | 71% |
| Ammunition and Explosives | $13,165,716,488 | 70% |
| Ship and Marine Equipment | $1,464,987,161 | 65% |
| Vehicular Equipment Components | $2,997,653,029 | 61% |
| Electrical and Electronic Equipment Components | $11,964,285,604 | 59% |
| Food and Beverages | $11,785,260,160 | 58% |
| Communications and Detection Equipment | $28,317,777,970 | 55% |
| Instruments and Laboratory Equipment | $6,496,703,459 | 51% |

| Most Competitive Categories | Total | Full & Open w/multiple bidders |
|---|---|---|
| Fuels, Oils & Lubricants | $24,450,584,124 | 81% |
| Medical, Dental and Veterinary Equipment & Supplies | $7,810,113,138 | 80% |
| Chemicals and Chemical Products | $2,634,514,879 | 80% |
| Space Vehicles | $2,867,529,030 | 78% |
| Medical Services | $24,563,339,971 | 78% |
| Construction of Structures and Facilities | $42,396,893,851 | 76% |
| Operation of Government-Owned Facilities | $11,218,471,798 | 66% |
| Hazardous Substance and Natural Resources Management | $9,234,078,017 | 64% |
| Technical Representative Services | $6,253,625,480 | 64% |
| Maintenance & Repair of Real Property | $34,430,112,159 | 61% |
| Lease or Rental of Equipment | $2,021,813,249 | 51% |
| Materials Handling Equipment | $1,745,198,018 | 51% |
| Equipment Maintenance, Repair & Rebuilding | $42,372,061,870 | 50% |

iii. The 737 biggest defense contractors spent almost $214 million in campaign contributions from 1998 to 2003. Table 7 lists the contributions of the 10 biggest defense industry contractors for that period. The majority of the money went to Republicans.

**Table 7. Contributions by the 10 Biggest Defense Industry Contractors (Makinson, 2004)**

| Name | 98-03 Contributions | Dems | Repubs |
|---|---|---|---|
| Lockheed Martin | $6,625,986 | 38% | 61% |
| Boeing Co | $5,313,529 | 41% | 59% |
| Raytheon Co | $3,226,729 | 41% | 59% |
| Northrop Grumman | $3,715,150 | 34% | 66% |
| General Dynamics | $4,367,384 | 40% | 60% |
| United Technologies | $2,238,693 | 42% | 58% |
| General Electric | $4,885,867 | 41% | 59% |
| Science Applications Intl Corp (SAIC) | $2,117,163 | 37% | 63% |
| Carlyle Group | $1,640,945 | 31% | 69% |
| Newport News Shipbuilding | $1,593,104 | 28% | 72% |

According to Makinson, President George W. Bush received more than $5 million in contributions from the major defense contractors and Senator John Kerry received less than $2 million from 1998 to end of July 2004. Table 8 lists the top recipients of direct contributions to their campaign committees from 1998 to 2003.

**Table 8. Top Recipients to Candidate Campaign Committees (Makinson, 2004)**

| Recipient | To Candidate | To Leadership PAC | Total |
|---|---|---|---|
| President George W Bush (R) | $4,546,679 | $0 | $4,546,679 |
| Sen Ted Stevens (R-AK) | $939,165 | $28,500 | $967,665 |
| Rep John P Murtha (D-PA) | $932,224 | $0 | $932,224 |
| Sen Richard C Shelby (R-AL) | $928,518 | $95,400 | $1,023,918 |
| Rep Tom DeLay (R-TX) | $873,074 | $21,625 | $894,699 |
| Sen John McCain (R-AZ) | $850,585 | $64,100 | $914,685 |
| Sen Trent Lott (R-MS) | $835,052 | $50,910 | $885,962 |
| Rep Duncan Hunter (R-CA) | $812,652 | $36,750 | $849,402 |
| Rep W J "Billy" Tauzin (R-LA) | $733,396 | $6,000 | $739,396 |
| Sen Don Nickles (R-OK) | $696,748 | $51,200 | $747,948 |
| Rep Heather Wilson (R-NM) | $688,502 | $0 | $688,502 |
| Rep James P Moran (D-VA) | $683,222 | $14,000 | $697,222 |
| Rep Tom Davis (R-VA) | $673,922 | $83,975 | $757,897 |
| Rep Henry Bonilla (R-TX) | $664,571 | $30,200 | $694,771 |
| Sen Rick Santorum (R-PA) | $659,407 | $15,350 | $674,757 |
| Rep Michael G Oxley (R-OH) | $653,900 | $11,800 | $665,700 |
| Sen Spencer Abraham (R-MI) | $648,326 | $15,000 | $663,326 |
| Rep Roy Blunt (R-MO) | $646,481 | $9,650 | $656,131 |
| Sen Christopher S Bond (R-MO) | $632,845 | $0 | $632,845 |
| Al Gore (D) | $626,264 | $45,200 | $671,464 |

Most of the members of Congress listed above are members of the House and Senate Defense Appropriations Subcommittees. Table 9 lists the members of Congress that operate “leadership PACs” in order to collect contributions for other members of Congress, for new candidates running for the first time for a seat in the Congress, it also shows that personal PACs which collected the most money from defense contractors.

**Table 9. Top Recipients to Leadership PACs (Makinson, 2004)**

| Recipient | To Leadership PAC | To Candidate | Total |
|---|---|---|---|
| Rep J Dennis Hastert (R-IL) | $1,100,173 | $46,200 | $1,146,373 |
| Rep Jerry Lewis (R-CA) | $1,002,199 | $54,750 | $1,056,949 |
| Rep Richard A Gephardt (D-MO) | $620,550 | $68,950 | $689,500 |
| Rep Joe Barton (R-TX) | $565,172 | $20,200 | $585,372 |
| Rep Don Young (R-AK) | $497,870 | $66,350 | $564,220 |
| Rep Martin Frost (D-TX) | $489,644 | $39,450 | $529,094 |
| Sen Tom Daschle (D-SD) | $471,170 | $68,775 | $539,945 |
| Rep David Dreier (R-CA) | $397,750 | $14,000 | $411,750 |
| Sen Mitch McConnell (R-KY) | $376,482 | $75,052 | $451,534 |
| Sen John B Breaux (D-LA) | $364,273 | $23,950 | $388,223 |
| Sen John Ashcroft (R-MO) | $359,306 | $94,585 | $453,891 |
| Sen James M Inhofe (R-OK) | $356,697 | $56,550 | $413,247 |
| Sen Larry E Craig (R-ID) | $310,790 | $32,250 | $343,040 |
| Rep Deborah Pryce (R-OH) | $284,493 | $9,900 | $294,393 |
| Rep Charles B Rangel (D-NY) | $265,750 | $24,700 | $290,450 |
| Rep John S Tanner (D-TN) | $246,041 | $1,800 | $247,841 |
| Rep Jim Nussle (R-IA) | $242,250 | $26,844 | $269,094 |
| Rep Mark Foley (R-FL) | $214,603 | $7,500 | $222,103 |
| Rep Frederick Upton (R-MI) | $210,694 | $6,250 | $216,944 |
| Rep John R Kasich (R-OH) | $207,450 | $48,550 | $256,000 |

Outside of campaign contributions, political influence is measured through lobbying expenses. According to Makinson (2004), the defense contractors spent nearly $1.9 billion dollars on Washington lobbyists from 1998 to 2003. Table 10 lists the 10 biggest defense contractors and how much money they have spent on lobbying efforts. Figure 14 gives a graphical representation of the total amounts spent by the five biggest defense contractors in both lobbying and campaign contributions from 1998 to 2003.

**Table 10.Lobbyist Spending**

**Lobbyist Spending by the 10 Biggest Defense Contractors**

| Name | 98-03 Lobby Spending |
|---|---|
| Lockheed Martin | $71,454,870 |
| Boeing Co | $64,390,810 |
| Raytheon Co | $27,461,500 |
| Northrop Grumman | $61,150,346 |
| General Dynamics | $37,011,522 |
| United Technologies | $24,133,633 |
| General Electric | $88,416,756 |
| Science Applications Intl Corp (SAIC) | $12,510,250 |
| Carlyle Group | $15,221,560 |
| Newport News Shipbuilding | $12,855,000 |

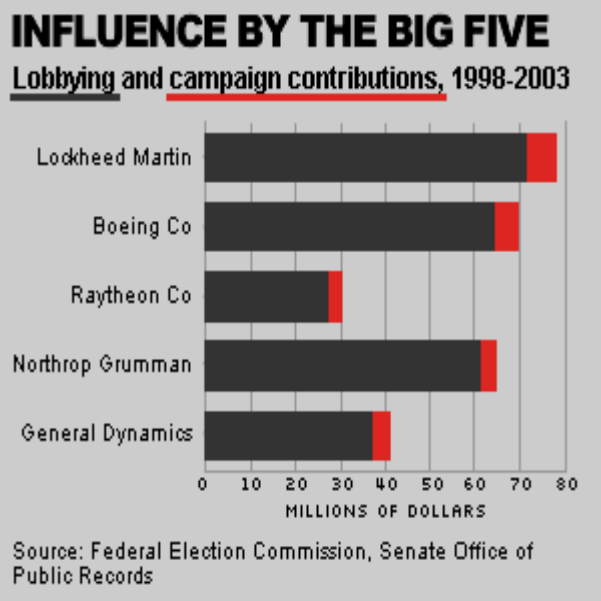



**Figure 14.Lobbying and Campaign Contributions (Makinson, 2004)**

iv. During the 1980s, almost two third of the defense procurement budget was used to buy products like aircrafts, tanks, and bullets. During the early 1990s, the procurement of services started to increase rapidly. In 2003, almost 56% of the contracting dollars went to services. Figure 15 provides a graphical representation of the transition from product contracts to service contracts.

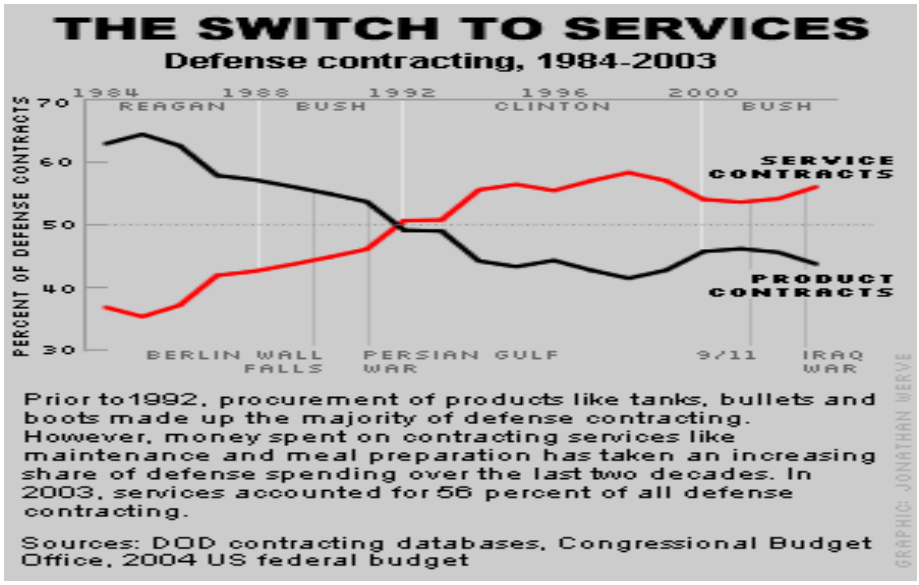


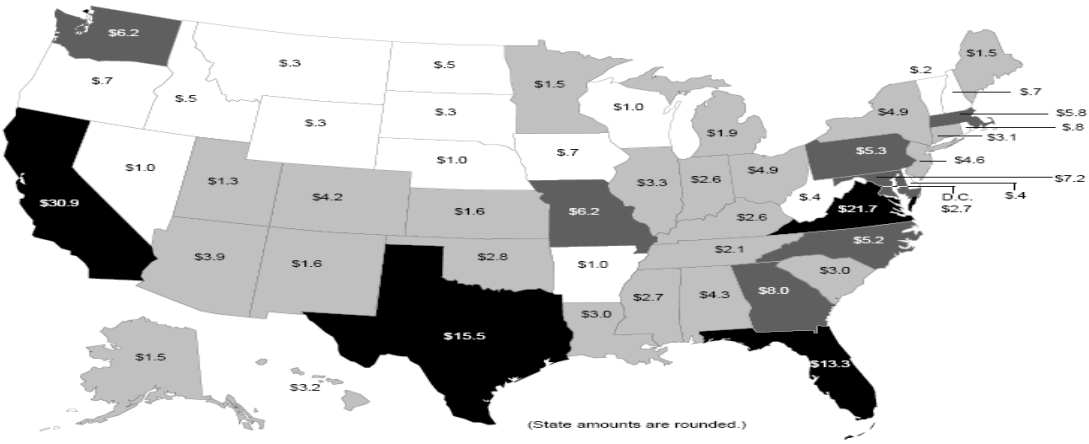

**Figure 15. The Switch to Services (Makinson, 2004).**

The results of Makinson's study provide insight on the relationship between the defense industry and the members of Congress, as well as the President of the U.S. Furthermore the study identifies patterns regarding the ways that defense contracts are awarded to well connected defense companies. Makinson's study, in concert with the rest of the literature review, helped this research to identify potential predictor variables, which are the political and legislative balances of power between the parties that control either or both the House and Senate, and that also supports the President of the U.S during the presidential elections, and the point where the spending for defense product contracts became equal with the spending for defense services contract.

**f. Defense Spending: Trends and Geographical Distribution of Prime Contract Awards and Compensation by the United States General Accountability Office (1998).**

According to a GAO report, "the DoD spends over $200 billion annually for contracts and compensation across the country. These dollars entering each state's

economy, are generally associated with employment and other economic benefits" (GAO, 1998:1). The GAO report examined the overall trends and the geographical distributions of the defense spending between 1988 and 1997. It examined defense spending, which includes the prime DoD contracts awards and compensation (military active duty and civilian pay, reserve, national guard pay and retired pay), in conjunction with each state's population and income tax contributions. All data were adjusted for inflation and are shown in FY 1997 dollars (GAO, 1998:1). The results of the GAO research show that prime contracts awards declined from 1988 to 1997 from $164 to $107 billion, with California experiencing the biggest decrease, and compensation decreased from $111 to $97 billion. Furthermore, almost 40%, or $81 billion, of defense prime contracts and compensation for 1997 were infused in California, Virginia, Texas, and Florida (see Figure 16).




| Dollars in billions | States | Amount spent | Percent |
|---|---|---|---|
| Over $10 | 4 | $81.4 | 39.9 |
| $5-10 | 7 | 43.9 | 21.5 |
| $1- 5 | 24 | 69.0 | 33.9 |
| Under $1 | 16 | 9.6 | 4.7 |
| **Total** | **51** | **$203.9** | **100.0** |

**Figure 16. DoD Spending for 1997 (GAO 1998)**

Finally, GAO examined defense spending against state population and income tax contributions and found that large variances occurred within these measures, (see Figures 17 and 18 (GAO, 1998)).

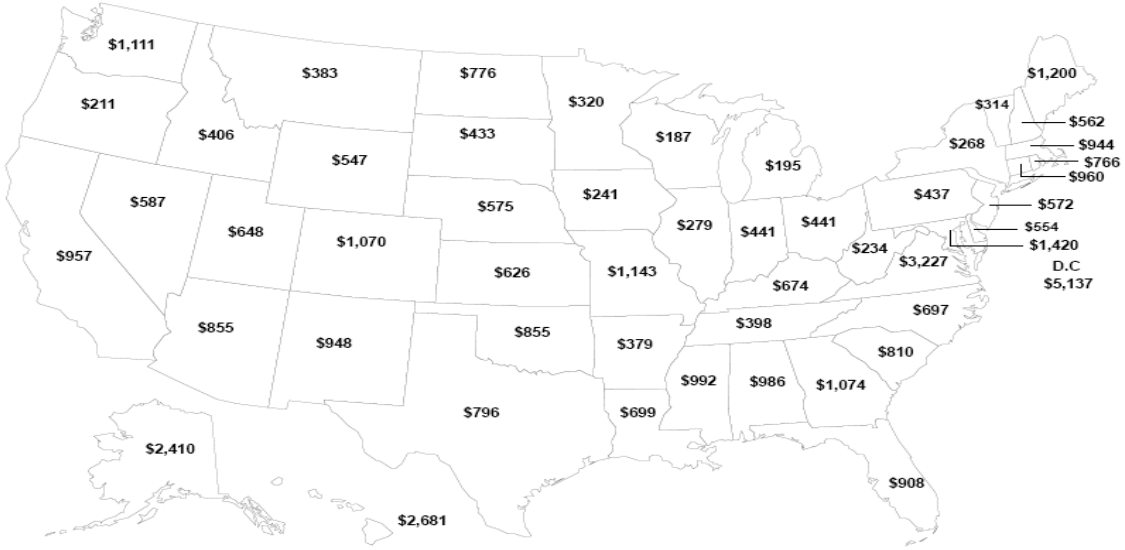



**Figure 17. Per Capita Amounts for DoD Spending 1997 (GAO 1998).**

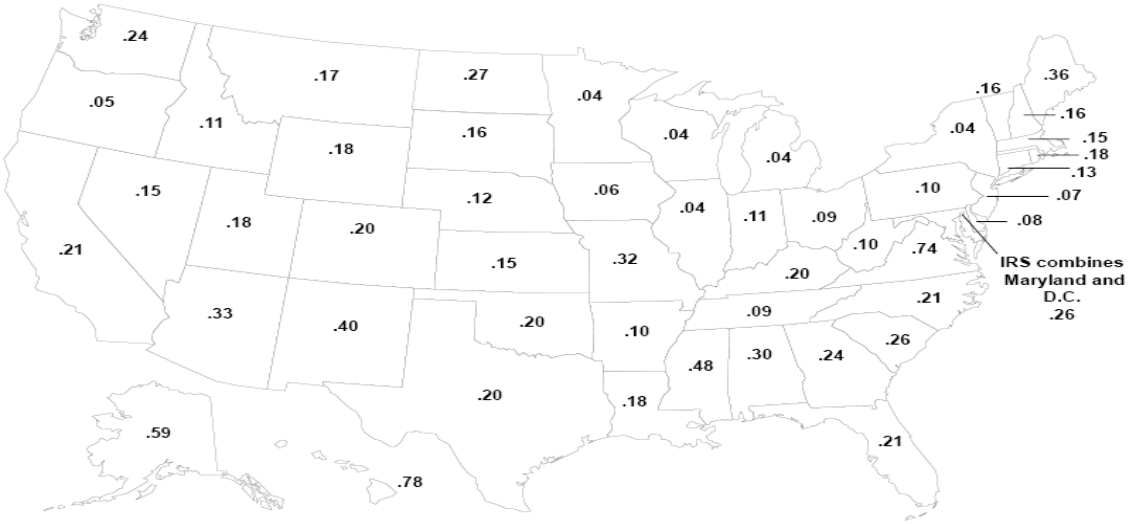



**Figure 18. DoD Spending per $ of personal Tax Contributions for 1996 (GAO 1998).**

**Summary**

Cost growth is a growing problem for DoD. During the last years many studies took place in order to discover and cure the factors that create cost growth in the defense programs. Many of the factors that identified are related to the program itself. For these factors DoD has taken many initiatives in order to eliminate or reduce their magnitude. This literature review reviewed, cost growth and the factors that are considerate to be responsible for it, and the actions taken by DoD in order to eliminate or reduce the effect of most of these factors. In addition it examined cost growth from a different perspective looking at it through the political process and how this process contributes to cost growth of the defense programs. Mainly it focused on the way that legislators make decisions. It examined the voting behavior of the members of the congress and the reasons that drive this behavior. This literature review tried to show that cost growth is related with the way that congress members vote for the various defense programs and the way they are spreading the manufacturing capacity across the various districts and/or states. Finally the literature review identified the research variable and potential predictor variables that will be used in the building of the predictive regression model.

## III. Methodology

### Research Model

The relationships between variables represent the core of research. The main objective of research is to assess causal relationships among variables at the conceptual and operational level. An empirical research model links all the variables and their relationships, as it is described by Schwab (2005:14), in the following way:

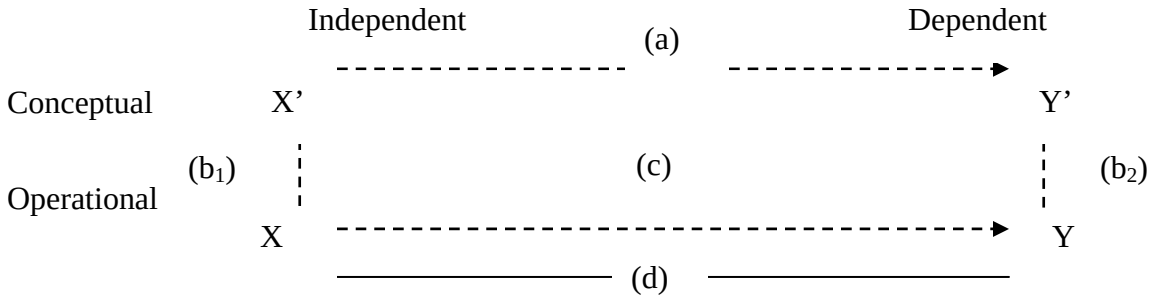



**Figure 19. Empirical Research Model (Schab, 2005:14)**

Where:

X': Political nature of the defense acquisition process, especially as it relates to the role of Congress in overseeing and managing the budgetary and acquisition process.

Y': How is the growth of costs for the various defense programs being influenced by the political nature of the defense acquisition process, through the dispersion of political and legislative power of the U.S. Constitution, among the House of Representatives, the Senate, and the President of the U.S.?

X: a. Political and legislative balance of power between the Parties that control either or both the House and Senate, and that also supports the President of the U.S during the presidential elections.

b. The change of the purchase habits of the DoD due to the switch of the majority of defense procurement from product contracts to service contracts.

c. Dispersion measure. This relates to the spreading of manufacturing capacity across the various states, as they are represented in the Armed Services Committee of both the House and Senate, through their elected Senators and Representatives.

Y: Cost overruns of the various defense programs as it has been captured in the DAES database through the Cost Performance Report (CPR) as of June 2002. This research will focus its effort at the operational level where empirical relationships will be observed between the independent and the dependent variables. According to the research model there are four issues that are going to influence this research.

a. Existence of a causal conceptual relationship between the constructs and the validity of this relationship (horizontal line a). The following hypothesis will be tested:

- The political nature of the defense acquisition process, especially as it is related to the role of Congress in overseeing and managing the budgetary and acquisition process, and the way the political and legislative power of the U.S. Constitution is spread among the House of Representatives, the Senate, and the President of the U.S., has a positive influence on cost overruns in the various defense programs. This research will obtain information in order to test the validity of my hypothesized relationships.

b. Existence of an empirical relationship (horizontal line d) - Statistical procedures (OLS method) will be used to determine if a correlation between the scores on the measures of X and Y exist. The statistical procedures will provide evidence regarding

the existence of any relationships and their direction, if they exist, between the operational variables (X) and cost overruns in the various defense programs (Y), which is the research variable.

c. Internal validity issues (horizontal line c) - According to Schwab (2005:15) internal validity is accessed when the following criteria are met:

- An empirical relationship is found
- Cause precedes effect
- There are no alternate plausible explanations.

As I mentioned earlier, an empirical relationship will be supported through statistical procedures. It is reasonable to suppose that cause precedes effect since the data for cost growth cannot be collected unless the various programs have been decided and approved by the members of the Congress. Alternate plausible explanations for the existence of cost overruns exist and some of them have been previously identified in the literature review. Variables like Budget, Unexpected Inflation, and Gross Domestic Product (GDP) that have been identified to contribute in the explanation of cost overruns will be used as control variables in order to achieve internal validity.

Furthermore, the integrity and reliability of the reported EVM data by the program managers through the cost performance reports can be questioned, which may threaten the internal validity. This research assumes that the data are reliable since the reporting data follow the Earned Value Management System (EVMS) criteria set by the government.

d. Construct validity issues (vertical lines b1, b2) - In order to achieve construct validity, the research followed the construct validation steps described by Schwab in Figure 20 (Schwab, 2005:16). We defined the constructs and developed a conceptual meaning for them. The measures were chosen to be consistent with the definitions and the obtained observations on the chosen measures were in accordance with the conceptual definitions. Construct validity is supported.

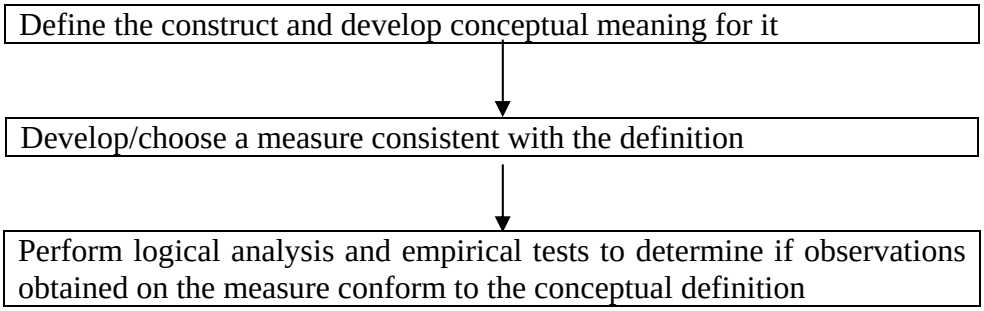



**Figure 20. Construct validation steps (Schwab, 2005:16)**

**Database**

This research effort will utilize data from the Defense Acquisition Summary (DAES) in order to conduct its analysis. Cost performance data will be gathered from the DAES database as of June 2002 for all the Acquisition Category (ACAT) I programs. ACAT I programs are those that require more than $365 million in research and development or greater than $2.19 billion for procurement in FY 2000 dollars. DAES is a multipart document which reports program information and assessments from the office of the program manager, who reports quarterly. The DAES database was established in 1984 and is maintained by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD [AT&L]. It contains cost and schedule performance data on more than 500 completed and on going contracts dating back to 1970. DAES

serves as an internal DoD management process and reporting tool, provides an early warning report to the DoD leadership, and serves as a feedback tool for the defense community (Christensen and Templin, 2002:107 and Holbrook, 2003:33). Figure 21 provides a graphical presentation of the DAES information flow chart.

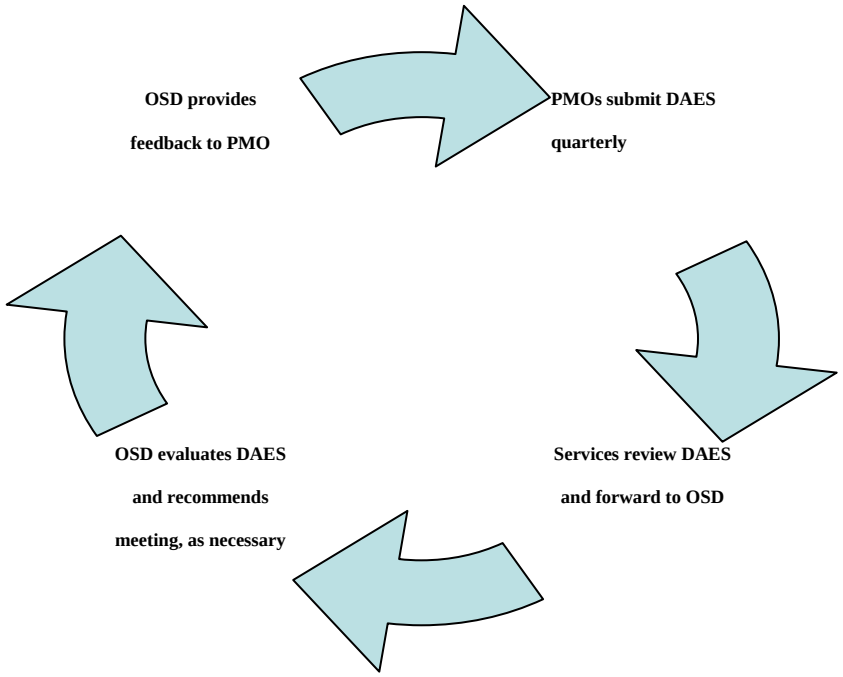



**Figure 21. DAES Flowchart**

This study will utilize EVM data taken from the DAES database. The contractors are required by the DoD to report detailed information about the cost and schedule status of the various defense programs through the CPR, a monthly management report. The government program offices utilize the CPR and prepare their quarterly report for the DAES (Christensen, 1999:284, Christensen and Templin, 2002:108, and Holbrook, 2003:33). Earned value is the key metric of this report. The reliability of the data is controlled by the obligation of the contractors to comply with the EVMS criteria.

The DAES database summarizes all the EVM required for this research effort. Cost performance data of the DoD's contracts represent a snapshot over time. DAES data will provide the necessary information to identify the programs that experience cost growth. The mean cost overrun percentage for each year will be calculated and used as the dependent variable. The DAES database contains a number of data fields. The following fields, in consistent with Holbrook's research, will be used for the purposes of this research (Holbrook, 2003:34):

- ✓ Submit date: the date the CPR is submitted to OUSD [AT&L] for inclusion into the database.
- ✓ Actual Cost of Work Performed (ACWP)
- ✓ Budgeted Cost of Work Performed (BCWP)

Information concerning the formation of the Committees, the state from which each of the members of the Committee has been elected, will be collected from the official website of the U.S. Senate and House of Representatives. Also data on the employment rates of the states that have establishments registered in the defense manufacturing industry will be collected. The employment rates and the composition of the Armed Services Committees of the Congress will be used to calculate the two measures of the dispersion of the defense manufacturing capacity across the country.

Finally data will be collected for the political parties that had the majority of both the Houses of Congress, and have supported the president during the presidential elections, from 1970 to 2002. The various combinations will be used as predictor variables.

## Research Population and Sample

The research population consists of all the contracts reported in the DAES database up to June 2002. Contracts that didn't have data or both BCWP and ACWP were eliminated from the research population, since cost performance cannot be assessed without this information (DSMC Gold Card, 2006). The remaining contracts form the research sample for which analysis will be performed. This research used all the available contracts in the DAES database and didn't split them by service, because all contracts are managed under the same regulations and legislation, and both the DoD and Congress are concerned with DoD contracts in total, not with Service-specific contracts. The research sample consists of 14,493 entries from 193 programs. A complete list of the programs studied and the number of contract entries per program can be found in Appendix B.

## Research Variable

The cornerstone study of the literature review that helped to identify and calculate the research variable for this research was Holbrook's study. Consistent with Holbrook's research, cost performance data will be gathered from the DAES database as of June 2002. Acquisition Category (ACAT) I programs will be examined. ACAT I programs are those that require more than $365 million in research and development or greater than $2.19 billion for procurement in FY 2000 dollars. Cost performance data of the DoD's contracts will represent snapshots over time which are determined by the DAES submittal dates as reported in the DAES database. The mean cost overrun percentage for each year will be calculated and be used as the dependent variable. According to Makridakis, Wheelwright, and Hyndman (1998:29), the mean helps to eliminate spikes caused by a

period of larger contracts or a period of smaller contracts and helps to account for differences in reporting from year to year. Finally the mean provides a measure of the midpoint for the ACWP, BCWP and CO. The mean cost percentage is calculated as a positive number for overruns and a negative number for underruns by using the following equations.

$$\overline{CO\,\%_k} = \frac{\overline{CO_k}}{\overline{BCWP_k}} * 100 \qquad (5)$$

Where: k = the kth year of DAES reporting and,

$$\overline{CO_k} = \overline{ACWP_K} - \overline{BCWP_k} \qquad (6)$$

The mean ACWP for each of the years is calculated as follows:

$$\overline{ACWP_k} = \frac{(\sum_{j=1}^{m} \overline{ACWP_j})}{m} \qquad (7)$$

Where: j = the jth monthly submittals in year k, and m = total number of monthly submittals in year k.

Finally the mean ACWP and BCWP for each submittal date are calculate as follows:

$$\overline{ACWP_j} = \frac{(\sum_{i=1}^{n} ACWP_i)}{n} \qquad (8)$$

$$\overline{BCWP_j} = \frac{(\sum_{i=1}^{n} BCWP_i)}{n} \qquad (9)$$

Where: i = the ith submittal in month j, and n = total number of submittals in month j.

**Predictor Variables**

The literature review identified many factors explaining the existence of cost overruns in the various defense programs. Most of these variables are related with the program itself and can be controlled by the DoD. Furthermore, factors were identified that are not related with the program directly but indirectly, such as the way Congress allocates scarce resources among the different public goods. We believe this is the first attempt to answer this question. This study tries to identify variables, which explain a part of the variation in cost overruns in the defense programs that are related to the political forces of the U.S. Congress, given their responsibility for allocating funds to the various defense programs through the appropriation bills. Table 11 lists the predictor variables that will be tested in the hope of finding some correlation between these variables and the cost overrun experienced in the programs of our research population:

**Table 11. List of Independent Variables**

| **PREDICTOR VARIABLES** | |
|---|---|
| **VARIABLE DESCRIPTION** | **VARIABLE NAME** |
| President Party | presp |
| Senate & House of Representatives Control Party | shorcp |
| Senate Party | sp |
| House of Representatives Party | horp |
| Senate, House of Representatives & President Control Party | shorprescp |
| Senate & President Control Party | sprescp |
| House of Representatives & President Control Party | horcp |
| Switch from Production contracts to Service contracts | switch1992 |
| Dispersion measure (Senate) | Dispersion~e |
| Dispersion measure (House of Representatives) | dispersion~r |

- President Party: The party that supported the president during the presidential elections. This variable will be a binary variable. 1 for the Democratic party and 0 for the Republican Party (DEMOCRATS=1 & REBUBLICANS=0).
- Senate & House of Representatives Control Party: If the same party controls both Houses of Congress. This variable will be a binary variable, 1 if the same party controls both of the houses, 0 otherwise (SAME PARTY: YES=1 & NO=0).
- Senate Party: The party that has the most Senators elected and controls the Senate for the specific year. This variable will be a binary variable, 1 for the Democratic party and 0 for the Republican party (DEMOCRATS=1 & REPUBLICANS=0).
- House of Representatives Party: The party that has the most Representatives elected, thus controlling the House of Representatives for the specific year. This variable will be a binary variable. 1 for the Democratic party and 0 for the Republican party (DEMOCRATS=1 & REPUBLICANS=0).
- Senate, House of Representatives & President Control Party: If the same party that controls Congress also supports the President. This variable will be a binary variable, 1 if the same party that controls both of the houses also supports the President, 0 otherwise (SAME PARTY=1 & OTHERWISE=0).
- Senate & President Control Party: If the same party that controls the Senate also supports the President. This variable will be a binary variable, 1 if the same party that controls the Senate also supports the President, 0 otherwise (SAME PARTY=1 & OTHERWISE=0).

- House of Representatives & President Control Party: If the same party that controls the House of Representatives also supports the President. This variable will be a binary variable, 1 if the same party that controls the House of Representatives also supports the President, 0 otherwise (SAME PARTY=1 & OTHERWISE=0).

- Switch from Production contracts to Service contracts: Twenty years ago the majority of the defense procurement budget was used for products, with the remainder for services. In the early 1990's, this relationship started to change. More money started to go for service contracts. The literature review discussed the existence of a cut off date where the spending for defense product contracts became equal with the spending for defense services contracts. The literature identifies this point to be the year 1992. Prior to 1992, procurement contracts made up the majority of defense contracting. After 1992 the Defense spending on services contracts has taken spending on production contracts. This variable will be a binary variable, 1 prior to 1992 and 0 after (PRIOR 1992=1 & AFTER 1992=0

- Dispersion measure - The spreading of the manufacturing capacity across the various states, as they are represented in the Armed Services Committee of both the Houses, through their elected Senators and Representatives. Their constitutional role is to provide adequate funding through the use of appropriation bills. Congress performs its legislative duties through the House of Representatives and the Senate. Both use committees in order to shape and present the various appropriation bills (see Figure 22)

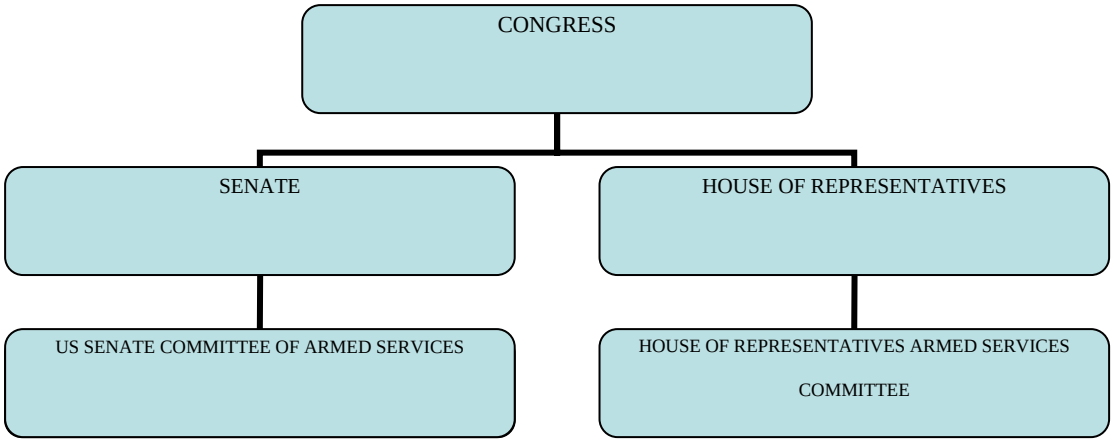



**Figure 22. The various parts of US Congress**

The level of dispersion of the manufacturing capacity across the country is measured by the employment rates of the manufacturing industry and more specific the Transportation Equipment sector for each state from 1970 to 2002, as a ratio of the number of employees in those states that are represented on the Senate Armed Services Committee and the House of Representatives Armed Services Committee over the total employment of all the states that have establishments that are registered in the Transportation Equipment sector of the Manufacturing Industry. According to the U.S. Standard Industrial Classification (SIC) system which has been replaced by the North American Industry Classification System (NAICS), the Transportation Equipment Sector includes:

> establishments engaged in manufacturing equipment for transportation of passengers and cargo by land, air, and water. Important products produced by establishments classified in this major group include motor vehicles, aircraft, guided missiles and space vehicles, ships, boats, railroad equipment, and miscellaneous transportation equipment (US Census Bureau).

We assume that the Transportation Equipment sector of the Manufacturing Industry can adequately represent the variation of the employment rates of the Defense

Industry. The data for the measure dispersion were calculated through the following equations.

$$Dispersion_{Senate_j} = \sum_{i=1970}^{2002} \frac{x_i}{N_i}, \quad (10)$$

$$Dispersion_{House\ of\ Representatives_j} = \sum_{i=1970}^{2002} \frac{x_i}{N_i} \quad (11)$$

Where:

$Dispersion_{Senate_j}$ = The spreading of the manufacturing capacity across the various states, as they are represented in the Armed Services Committee of the Senate for each year from j=1970 to 2002

$Dispersion_{House\ of\ Representatives_j}$ = The spreading of the manufacturing capacity across the various states, as they are represented in the Armed Services Committee of the House of Representatives for each year from j=1970 to 2002

$x_i$ = ∑ (Transportation Equipment Sector Employment Rates of the States represented in the Armed Services Committee of the Senate/House of Representatives per each year from i=1970 to 2002)

$N_i$ =∑ (Transportation Equipment Sector Employment Rates of all the States per each year from i=1970 to 2002)

The necessary employment rates for the calculation of the dispersion measures for both the Senate and the House of Representatives Armed Services Committees were gathered from the Bureau of Labor Statistics (BLS). Paul Chester, an economist in the Current Employment Statistics (CES) State and Metro Area Program Bureau of Labor

Statistics (BLS), provided all the necessary data. Unfortunately, as he states, the data that goes back to 1970 are based on the old SIC system. Beginning in 2003, all government statistical agencies were required to convert and began publishing data on the NAICS classification system. As a result of this transition, data on NAICS and SIC were no longer comparable. This resulted in the loss of historical time series data. For this reason, some of the states had missing data. The BLS provided a second database that contained employment rates for the transportation equipment sector from 1990 to 2004. This database helped this research by identifying the existence of employment rates of the Transportation Equipment sector of the Manufacturing Industry, for the states with missing data. Furthermore missing data for two of the states (Colorado and New Hampshire) were replaced with data from the second database. Finally there were five categories of missing data. These categories and the methodology used in order to replace the missing data are described in Appendix D. A part of the final employment rates used in this research is described in Appendix C.

Finally the data for the composition of the Armed Services Committees for both Houses of Congress were gathered through the official sites of the Congressional Library and the House of Representatives Armed Services Committee. This database was used to help calculate the numerator of the dispersion equation.

**Control Variables**

The control variables are variables that have been identified by the literature to contribute to the explanation of cost overruns. These variables help to achieve internal validity. The following variables (Table 12) will be used as control variables.

**Table 12. List of Control Variables**

| CONTROL VARIABLES | |
|---|---|
| **VARIABLE DESCRIPTION** | **VARIABLE NAME** |
| Defense Budget | dodbudget |
| Unexpected Inflation | inflation |
| % Change of the Gross Domestic Product | gdp |

- **Defense Budget** - The defense budget consists of all the resources and commitments required to fulfill the DoD goals for a specific period, which is usually a year. The literature review provided evidence that the fluctuation of the defense budget over the years (see Figure 2) due to radical changes in the balance of military power worldwide (e.g. the end of the Cold War) can cause cost overruns in the various defense programs. This research will use the annual percentage change of the defense budget (see Figure 23) in order to be in consistent with the research variable and facilitate interpretation of the model coefficients. The necessary data for this research (see Appendix E) have been gathered from Chapter 6 of the National Defense Estimates for 2006 report which is prepared annually by the Office of the Undersecretary of Defense (Comptroller) (Office of the Undersecretary of Defense (Comptroller), 2005:64).

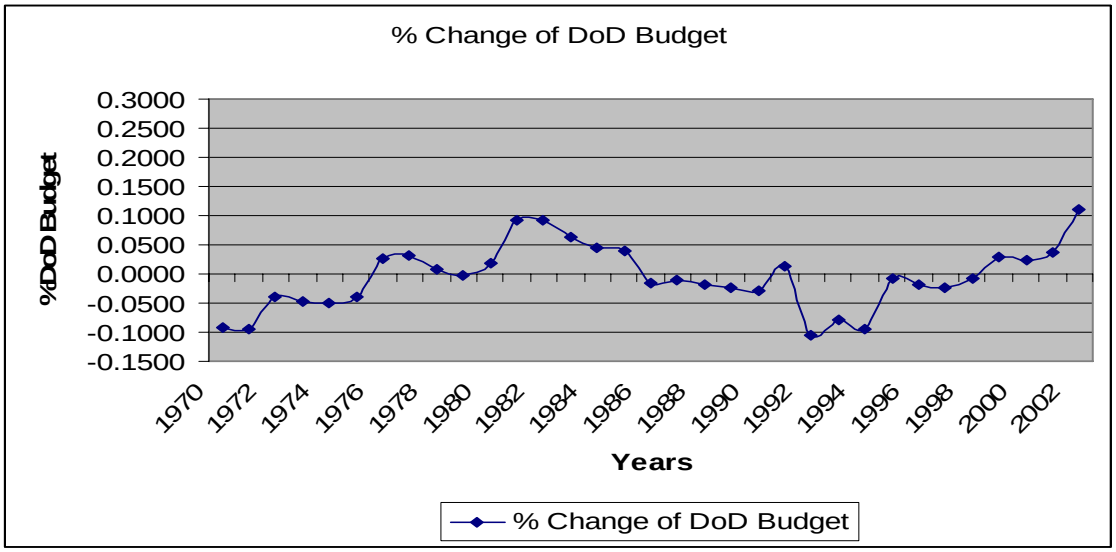



**Figure 23. % Change of DoD Budget (M) FY06 $ from 1970 to 2002**

➢ Unexpected Inflation – Estimating uncertainties and poor estimating has been identified by the literature review as a causal category of factors responsible for cost overruns. This category of factors affecting cost growth contains, among others, poor inflation estimates, which are used to foresee the cost of the Defense programs in the future years. The OSD Comptroller forecasts the inflation rates that will be used for calculating the future spending of the DoD. Since the inflation rates are forecasted, there will always be a difference between the actual inflation for a specific year with the forecasted one. Smirnoff modeled this discrepancy, which he called unexpected inflation, and tested to see if there is any correlation with cost overruns. Smirnoff defined the unexpected inflation as "the difference between actual inflation and expected inflation in the year the money is used" (Smirnoff, 2006:30). Consistent with Smirnoff's research, we will use data for unexpected inflation from 1980 to 2002 due to the lack of historical data

prior to 1980 (see Appendix F). Figure 24 provides a graphical representation of the percentage change of the unexpected inflation over time.

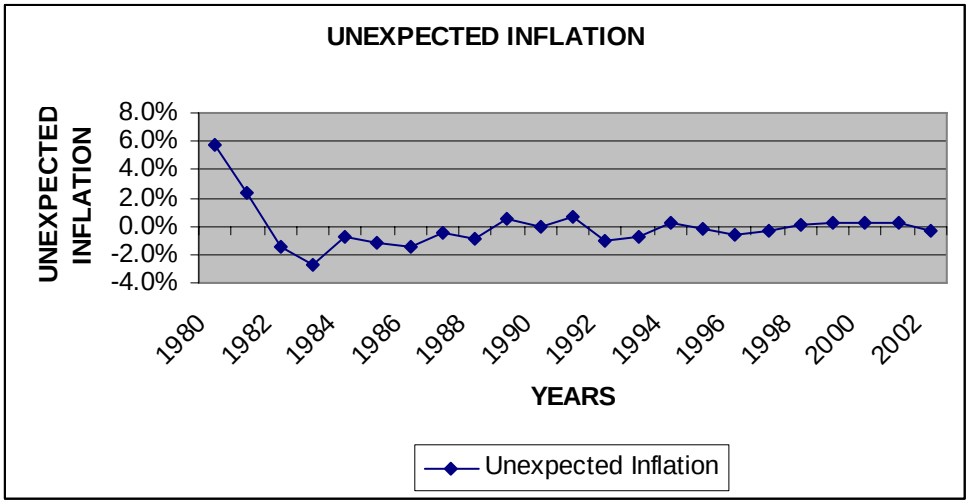



**Figure 24. Unexpected Inflation over Time**

- Gross Domestic Product (GDP) – Funding instability has been identified as a causal factor for cost overruns. This research will use GDP as a proxy of funding instability. A country's GDP is a measure of the size and the health of its economy. Figure 25 provides a graphical representation of the sectors contributing to the calculation of GDP.

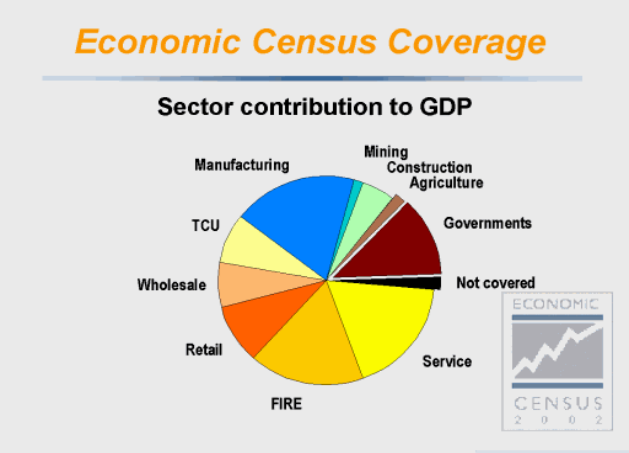



**Figure 25. Sector Contribution to GDP (US Census Bureau)**

According to the Economic Census of the United States, "GDP is the most important current measure of our Nation's economic performance. Estimated quarterly by the Bureau of Economic Analysis (BEA), GDP is a measure of the total market value of all final goods and services produced in our country during any quarter or year." GDP estimates are based on current statistics from the Census Bureau and other sources. Every 5 years, GDP estimates are benchmarked to the Economic Census. (US Census Bureau, 2002 Economic Census). Annual real GDP data were gathered from the BEA. This research will use the percentage change of annual GDP values as an independent variable. A table of the GDP values is presented in Appendix F. Figure 26 provides a graph of the % change of GDP over time.

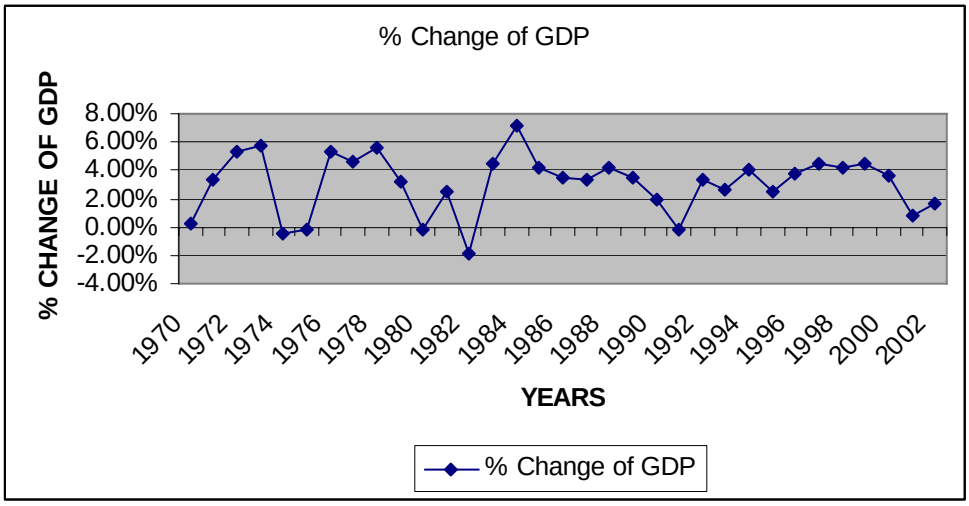



**Figure 26. % Change of GDP over time**

**Method**

Employing the data gathered and described in the former paragraphs we hypothesize the following econometric relationship: Y=f(X, Φ). Where Y is the mean cost overrun percentage for each year, X accounts for the political specific characteristics, and Φ contains all the control variables used in this research. Simplicity is the cornerstone of any empirical research. Thus this research will present a simple statistical model using multiple regression, using Ordinary Least Square (OLS) with more than one predictor variables. For this research the model will be as follows:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots\ldots + \beta_k x_k + \varepsilon \qquad (12)$$

The values of the parameters $\beta_0, \beta_1, \beta_2, \ldots\ldots\ldots, \beta_k$ are estimated by the Method of least squares or OLS. This method produces a line that minimizes the sum of the squared vertical distances from the line to the observed data points (residuals). The Gauss–Markov theorem states that in a linear model in which the errors have expectation of zero,

are uncorrelated, and have equal variances, the best linear unbiased estimators of the coefficients are the least-squares estimators.

The proposed model of this research is that contract cost overruns is a function of political and legislative balances of power between the Parties of the Congress, the change of DoD purchasing habits, spreading the manufacturing capacity across the various states, change in the level of DoD budget, inflation, and GDP such that:

$$\text{COST OVERRUN \%} = f\left(\begin{array}{l}\text{President Party + Senate \& House of Representatives Control Party + Senate Party + House of Representatives Party + Senate, House of Representatives \& President Control Party + Senate \& President Control Party + House of Representatives \& President Control Party + Switch from Product contracts to Service contracts + Dispersing measure (Senate) + Dispersing measure (House of Representatives)+ Defense Budget + Unexpected Inflation + \% Change of the Gross Domestic Product + error}\end{array}\right)$$

**Summary**

This chapter described the methodology used by this research in order to answer the investigative questions set at Chapter I. The database used for this research and the preparation of the data was comprehensively discussed. Furthermore, the predictor variables and the method used to create the empirical model were presented. Concerns and issues about, causal and empirical relationships, internal, external and construct validity were addressed. Finally, this chapter outlined the model building process and the process of analysis that is performed in the next chapter.

# IV. Analysis and Results

## Chapter Overview

This chapter presents the analysis described in Chapter 3. Recall that Chapter 3 provided the methodology used in order to conduct this research effort and answer the investigative questions presented in Chapter 1. The results of the Ordinary Least Square (OLS) regression and all the statistical tests and graphical analysis that support the analysis are presented in the following paragraphs.

## Results of Analysis

All the variables were checked for stationarity, using the Augmented Dickey Fuller Test (see Appendix J). Two of the variables, the dispersion measures for both the Senate and the House of Representatives, discovered to contain a unit root. Figure 27 provides a graphical representation of these variables. Figure 28 provides a plot of the employment rates of the defense manufacturing sector, and the employment rates of the states that are represented in the Armed Services Committees of the Senate and the House of Representatives over time.

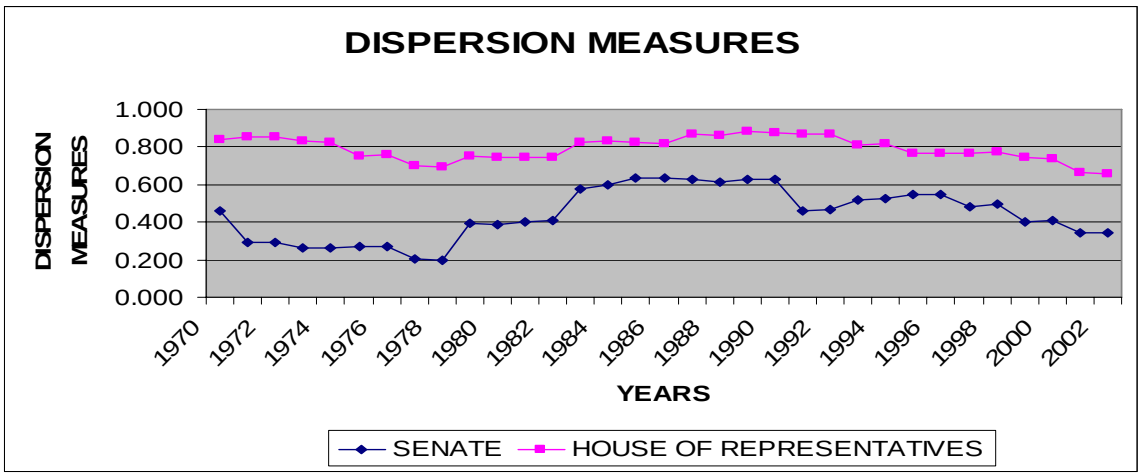



**Figure 27. Dispersion measures for the Senate and the House of Representatives.**

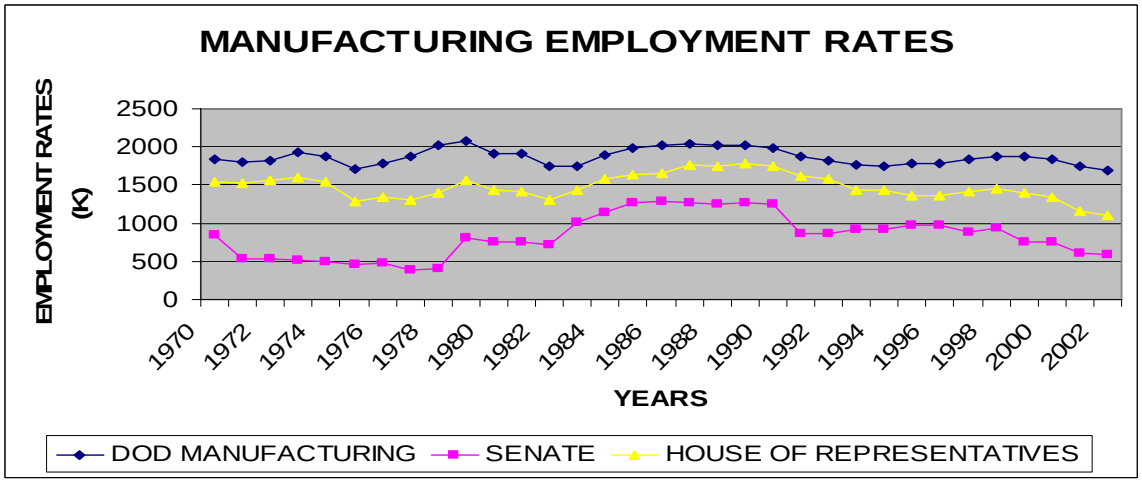



**Figure 28. Employment Rates Over Time**

In order to eliminate the unit root, both of the variables were transformed by taking the first difference. The transformed variables were checked for stationarity and were found to be first difference stationary. Having accounted for stationarity, the OLS regression results using Stata are presented in Table 13. As we can see three variables were dropped by stata because of perfect or high multicollinearity (Hamilton, 2006:210).

**Table 13. OLS Results**

| ORDINARY LEAST SQUARE REGRESSION | | | | |
|---|---|---|---|---|
| Ordinary Least Square Regression | | | Number of obs = | 23 |
| | | | F(9,13)= | 4.02 |
| | | | Prob>F= | 0.013 |
| | | | R-squared= | 0.7701 |
| | | | Adj R-squared= | 0.5785 |
| **DoDoverrunpercent100** | **Coef.** | **Std. Err.** | **t** | **P>\|t\|** |
| President Party | -18.35778 | 7.264813 | -2.53 | 0.027 |
| Senate & House of Represenattives Control Party | 20.78338 | 8.054457 | 2.58 | 0.024 |
| Senate Party | -1.696426 | 3.306113 | -0.51 | 0.617 |
| House of Representatives Party | (dropped) | | | |
| Senate, House of Representatives & President Control Party | (dropped) | | | |
| Senate & President Control Party | 14.56621 | 4.916775 | 2.96 | 0.012 |
| House of Representatives & President Control Party | (dropped) | | | |
| Switch from Production Contracts to Service Contracts | -10.30838 | 5.036422 | -2.05 | 0.063 |
| Dispersion measure (Senate) | -17.34183 | 20.2282 | -0.86 | 0.408 |
| Dispersion measure (House of Represenattives) | -49.87443 | 41.84019 | -1.19 | 0.256 |
| Defense Budget | 4.03117 | 39.16613 | 0.1 | 0.92 |
| Unexpected Inflation | -39.81446 | 87.93867 | -0.45 | 0.659 |
| % Change of the Gross Domestic Product | -83.11967 | 59.7123 | -1.39 | 0.189 |
| _cons | 3.36845 | 5.407881 | 0.62 | 0.545 |

Checking furthermore for multicollinearity we perform the VIF test. The VIF test doesn't show any traces of perfect or high multicolinearity (Table 14). A further treatment of multicolinearity by dropping another variable may lead to specification problem. Therefore we will continue with our analysis without a further treatment of multicollinearity.

**Table 14. VIF Results**

| **overrunpercent100** | |
|---|---|
| **Independent Variable** | **Variance Inflation Factor (VIF)** |
| Senate & House of Represenattives Control Party | 20.04 |
| President Party | 17.12 |
| Switch from Production Contracts to Service Contracts | 8.62 |
| Senate & President Control Party | 7.84 |
| Defense Budget | 6.26 |
| Senate Party | 3.71 |
| Unexpected Inflation | 2.57 |
| Dispersion measure (House of Represenattives) | 2.16 |
| Dispersion measure (Senate) | 1.99 |
| % Change of the Gross Domestic Product | 1.79 |
| Mean VIF | **7.21** |

The model residuals were tested for heteroskedastisity and found to have a constant variance. Table 15 presents the results of the Breush Pagan test for heteroscedastisity. As we can see the prob.>chi2 is greater than a=0.05, therefore we fail to reject the null hypothesis of constant variance and conclude that the model does not face heteroscedastisity issues.

**Table 15. Test for Constant Variance**

| **Breush-Pagan Test for Heteroscedasticity** | | |
|---|---|---|
| Ho: Constant Variance | | |
| **Estimated Results** | **Variance** | **Standard Deviation** |
| overrunpercent100 | 67.8955 | 8.2399 |
| residuals | 16.8898 | 4.1097 |
| chi2(1) | = | 2.64 |
| **prob>chi2** | **=** | **0.1043** |

Furthermore we test the model for autocorrelation. Table 16 presents the results of the Durbin Watson test for independence. As we can see the d-statistic is just below 2 indicating that no autocorrelation exists.

**Table 16. Test for Autocorrelation**

| **Durbin Watson Test for Independence** | |
|---|---|
| Durbin-Watson d-statistic (11,23)= | **1.863653** |

The regression results (Table 13) show that there is a:

a. Negative correlation between the following variables and cost overruns:

   i. President Party (Democrats or Republicans),

   ii. The switch from the production contracts to service contracts in 1992.

b. Positive Correlation between the following variables and cost overruns:

i. Whether the same party control the Senate and the House of Representatives,

ii. Whether the same party controls the Senate and the President.

Table 17 summarizes the impact of each of the independent variables on cost overruns, the coefficients of the model, and the assigned p-values for each of the independent variable. Independent variables that are not significantly correlated with the dependent variable are left blank on the impact column.

**Table 17. Summary of Results**

| DoD Cost Overruns Model | | | |
|---|---|---|---|
| | | R-squared= | 0.7701 |
| | | Adj R-squared= | 0.5785 |
| **INDEPENDENT VARIABLES** | **Impact** | **Coef.** | **P>\|t\|** |
| President Party | - | -18.35778 | 0.027 |
| Senate & House of Represenattives Control Party | + | 20.78338 | 0.024 |
| Senate Party | | -1.696426 | 0.617 |
| House of Representatives Party | | (dropped) | |
| Senate, House of Representatives & President Control Party | | (dropped) | |
| Senate & President Control Party | + | 14.56621 | 0.012 |
| House of Representatives & President Control Party | | (dropped) | |
| Switch from Production Contracts to Service Contracts | - | -10.30838 | 0.063 |
| Dispersion measure (Senate) | | -17.34183 | 0.408 |
| Dispersion measure (House of Represenattives) | | -49.87443 | 0.256 |
| Defense Budget | | 4.03117 | 0.92 |
| Unexpected Inflation | | -39.81446 | 0.659 |
| % Change of the Gross Domestic Product | | -83.11967 | 0.189 |

This model explains about 77% of the variability in the observed data for over 14,493 contracts and 193 programs of the DoD. Only the President Party, the Senate and House of Representatives control party, the Senate and President Party, and the switch from production contracts to service contracts in 1992 were clearly within the typical statistical significance reported in scientific research. According to the model, all else equal, if, for example, the President of the United States was a Democrat then a reduction of 18% of

the cost overruns will be resulted for that specific year. The rest of the variables were less statistically significant. Nevertheless the variable of dispersion of the House of Representatives even though it is statistically significant at the 75% level provided some insights about the behavior of the cost overruns as they are related to this variable. A reduction in the cost overruns will be resulted when:

a. There is an increase in the employment rates of the states that have a representative in the Armed Services Committee of the House of Representatives or,

b. There is a decrease in the total number of the employment rates of the defense manufacturing capacity across the country with not so over decrease in the employment rates of the states those are represented in the House Committee.

So in order to have reductions in cost overruns we should have the defense manufacturing capacity concentrate on the states that are represented in the Armed Services Committee of the House of Representatives and not dispersed all over the country.

Having presented the results of the OLS regression and all the statistical tests and graphical analysis that support the analysis we will continue by interpreting these findings and their implications and at the same time answering the investigative questions presented in Chapter I of this research.

**Investigative Questions Answered**

As we stated in Chapter I the purpose of this research was to investigate the existence of any relationship between the cost overruns in the various defense programs and the political nature of the defense acquisition process. In order to do that a set of

investigative questions was established. In the following paragraphs we will answer these research questions one by one.

- Does the political and legislative balances of power between the parties that control either, or, both the House of Representatives and the Senate, and that also supports the President of the U.S. during the presidential elections inflate cost growth on the various programs of the DoD?

The results of the analysis provided evidence that supports the existence of a relationship between the cost overruns in the DoD programs and the political and legislative balances of power between the parties of the Congress. More specifically,

a. The model suggests a negative correlation between the variable that represents the party (Democrats or Republicans) that supports the President of the U.S. during the presidential elections and cost overruns in the various Defense programs. When a President is supported by the Democrat Party a reduction in the cost overruns will be observed. Our model suggests that, all else being equal, having a Democrat president has reduce the cost overruns by 18.36% for that specific year.

b. The model suggests a positive correlation between the variable that represents whether the same party controls both of the Senate and the House of Representatives and cost overruns in the Defense programs. According to our model when the same party controls both of the Senate and the House of Representatives, all else being equal, the cost overruns for that year will be increased by 20.78%.

c. The model suggests a positive correlation between the variable that represents whether the party that controls the Senate also supports the election of the

President and cost overruns in the Defense programs. According to our model when the same party controls both of the Senate and the elected President, all else being equal, and the cost overruns for that year will be increased by 14.57%.

- Does the switch of the defense procurement budget from production contracts to service contracts contribute to the experience of cost growth in the Department of Defense major procurement activities and programs?

The results of the analysis provided evidence that supports the existence of a relationship between cost overruns in the DoD programs and the change of the purchasing habits of the DoD due to the switch of the majority of defense procurement from production contracts to service contracts starting in 1992. More specific our model suggests that the switch from production contracts to service contracts doesn't provide any reduction of cost overruns in the defense programs. On the contrary, according to our model, a reduction by 10% in the annual cost overrun percentage is observed, prior the switch from production contracts to service contracts.

- Does the dispersion of the defense manufacturing capacity across the various states, as they are represented in the Armed Services Committee of both of the House and Senate, through their elected Senators and Representatives, inflate cost growth in the DoD programs?

Our model doesn't provide any strong evidence that may support the existence of a relationship between cost overruns in the DoD programs and the spreading of the manufacturing capacity across the country. However the coefficient for our dispersion measure for the House of Representatives is big in magnitude and has a negative sign and

is statistically significant at the 25% level. This might indicate a weak negative relationship between cost overruns and the dispersion measure of the House of Representatives, meaning that when we have a reduction in the dispersion measure the cost overruns will increase. In order to have a decrease in the dispersion measure the employment rates of the states that are represented in the Armed Services Committee of the House of Representatives be reduced or the employment rates of the defense manufacturing sector are being increased with no so over increase of the employment rates of the states that are represented in the House Committee or the number of the states that are represented in the Armed Services Committee of the House of Representatives are reduced. An interpretation will be that a reduction in the employment rates in the states that are represented in the House of Representatives reduced will result to the reduce of the business of the companies that are located in those states which means loose of profit and eventually reduction in the employment force which means unsatisfied voters. Therefore in order for the voters to keep their job the companies should maintain their profitability. In order to do this either an increase of the cost in the existing programs will be requested resulting in cost overruns or new contracts to be given to the companies. The House of Representatives Armed Service Committee will definitely see in a positive way these overruns. As we said an increase in the employment rates of the defense manufacturing sector without any increase of the employment rates of the states that are represented in the House of Representatives Armed Service Committee will still lead in cost overruns. Therefore by spreading the manufacturing capacity across the country leads to an increase of cost overruns in the DoD programs.

Figure 29 provides a graphical presentation of the dispersing measures, for both the House and the Senate, and cost overruns over time. As we can see from the graph whenever the dispersion measure for the Senate decrease cost overruns increase for the same period. In order to have a decrease in the dispersion measure the employment rates of the states that are represented in the Senate Armed Services Committee will be reduced or the employment rates of the defense manufacturing sector will be increased or the number of the states that are represented in the Armed Services Committee of the Senate will be reduced. Therefore there is an indication that the dispersion of the manufacturing capacity across the country leads to an increase of the cost overruns in the DoD programs.

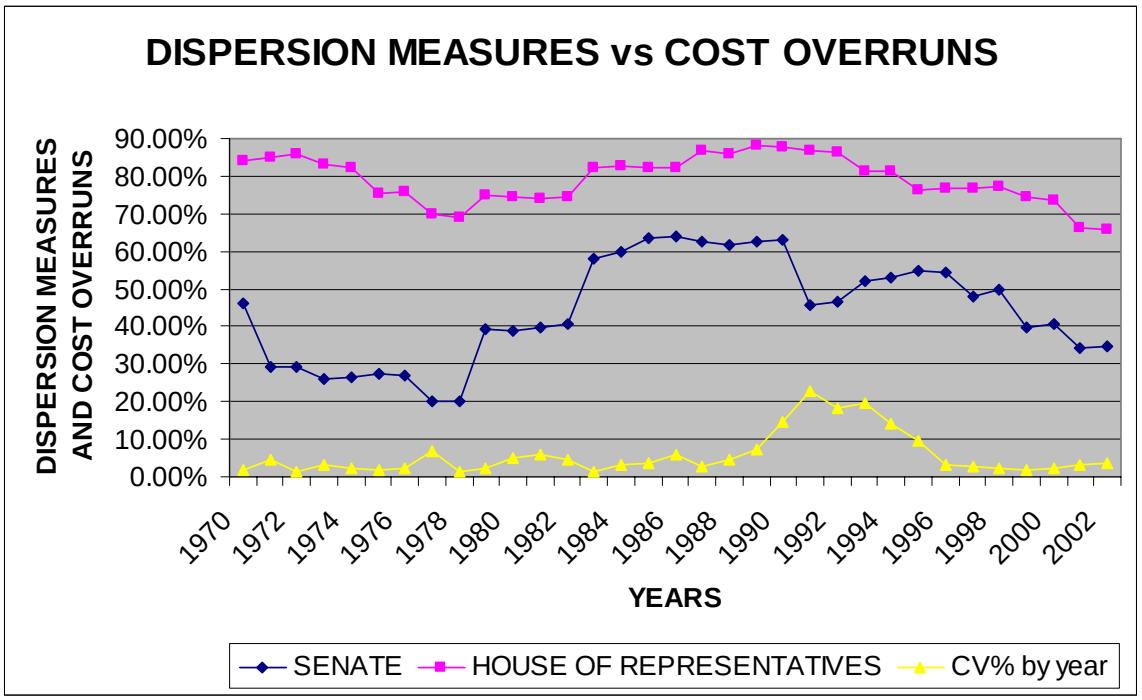



**Figure 29. Dispersion Measures vs Cost Overruns**

## Summary

In this chapter, we reported the results of the OLS regression and all the statistical tests and graphical analysis that support the significance of our model. We explained our findings and answered the research question set at Chapter I. In Chapter V we summarize these findings and their implications, and provide recommendations for future research.

# V. Conclusions and Recommendations

## Review of Research Objectives

The objective of this research was to develop an empirical model in order to explain cost overruns in the Department of Defense major procurement activities and programs. This research tried to discover relationships between cost overruns in the defense weapon systems programs and factors that the DoD cannot control, factors that originate from the political nature of the defense acquisition process. In order to achieve our objective we used the method of Ordinary Least Square regression.

## Conclusions of Research

The results of the OLS regression indicate that the political and legislative balances of power between the Parties that control either or both the House and Senate, and that also supports the President of the U.S. during the presidential elections, and the change of the purchase habits of the DoD due to the switch of the majority of defense procurement from production contracts to service contracts are correlated with the cost overruns in the Defense programs.

More specific the results show that a Democratic President leads to a reduction in cost growth, while control of both houses of Congress by one party, or control of the Senate and the office of the President by one party causes cost increases. In addition a decrease in cost overruns in the Defense programs has been realized prior the year 1992 which is the year that we have define as the change point from the production contracts to the services contracts. So the switch from production contracts to service contracts didn’t led to a decrease of cost overruns.

Further, research highlighted that the dispersion of defense manufacturing capacity across the country inflates cost overruns in DoD programs. In addition, the discussion on the analysis and the results of the OLS regression in Chapter IV provided signs, that a reduction in the defense manufacturing capacity (employment rates) of the states that are represented in both the Armed Services Committees of the Congress causes cost increases and that a/an reduction/increase of the numbers of the states that are represented in either of the two Armed Services Committees of the Congress causes an increase/decrease in the cost overruns of the DoD.

At last the following variables, % change of the DoD budget, unexpected inflation and % change in the GDP were not statistically significant in our model, even though they were identified by other studies as causal factors in cost overruns. The % change in the GDP variable has a high coefficient which is statistical significant at the 80% level. According to the model GDP is negative correlated with cost overruns. For example an increase of the GDP by 1% will reduce the cost overruns for that year by 0.83%.

**Recommendations for Future Research**

This research set the foundations for future research. There are two areas for future research that should be considered. First, the database used in this research is not complete. Employment rates per state for the industries of, Aerospace product and parts industries, Ship and Boat building, and other transportation equipment of the Manufacturing sector could be added in our database. These specific employment rates that represent more accurately the total defense manufacturing capacity will provide a

better proxy for representing the spreading of the defense manufacturing capacity across the country.

Another potential area for follow on research would be to use the analysis from this research and apply it:

d. to each of the Services (Air force, Navy, Army) and compare the results,

e. to each of the different phases of the program ( Production, Research and Development) and compare the results,

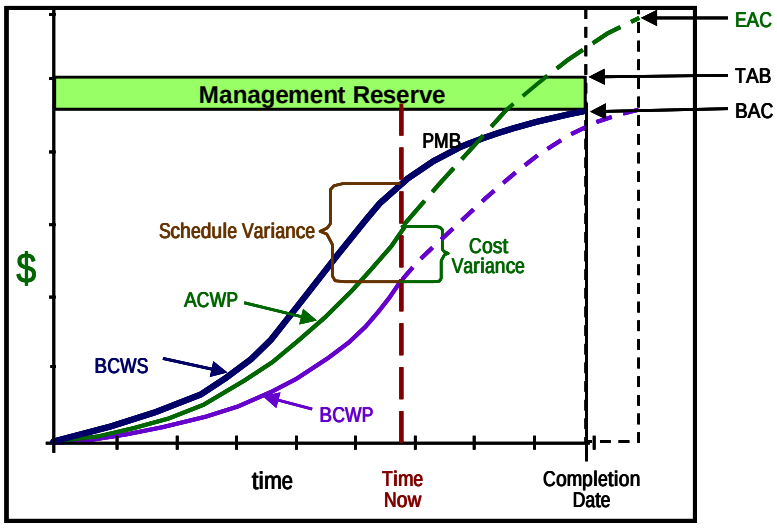
f. to each of the different contract types (Fixed price, Cost-plus) and compare the results.

## Appendix A. Earned Value Management Gold Card

# Earned Value Management

## 'Gold Card'

**Defense Acquisition University**




### VARIANCES

Favorable is Positive, Unfavorable is Negative

| | | | |
|---|---|---|---|
| Cost Variance | CV | = BCWP – ACWP | CV % = (CV / BCWP) *100 |
| Schedule Variance | SV | = BCWP – BCWS | SV % = (SV / BCWS) * 100 |
| Variance at Completion | VAC | = BAC – EAC | |

### PERFORMANCE INDICES

Favorable is > 1.0, Unfavorable is < 1.0

| | | |
|---|---|---|
| Cost Efficiency | CPI | = BCWP / ACWP |
| Schedule Efficiency | SPI | = BCWP / BCWS |

### OVERALL STATUS

| | |
|---|---|
| % Schedule | = ($BCWS_{CUM}$ / BAC) * 100 |
| % Complete | = ($BCWP_{CUM}$ / BAC) * 100 |
| % Spent | = ($ACWP_{CUM}$ / BAC) * 100 |

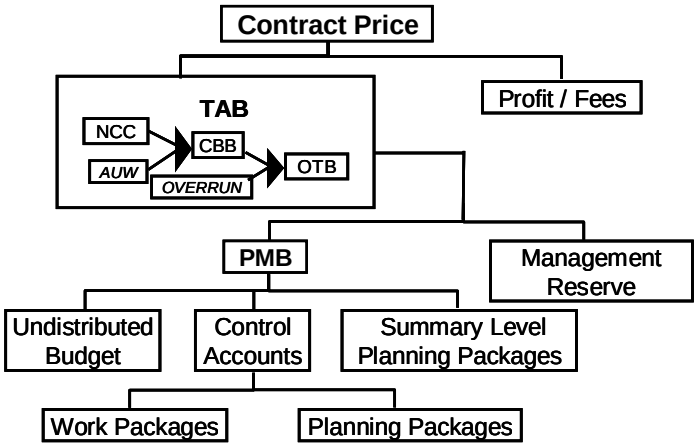
### ESTIMATE AT COMPLETION #

| | | |
|---|---|---|
| EAC | = Actuals to Date + | [(Remaining Work) / (Efficiency Factor)] |
| $EAC_{CPI}$ | = $ACWP_{CUM}$ + | [(BAC – $BCWP_{CUM}$) / $CPI_{CUM}$] = **BAC / $CPI_{CUM}$** |
| $EAC_{Composite}$ | = $ACWP_{CUM}$ + | [(BAC – $BCWP_{CUM}$) / ($CPI_{CUM}$ * $SPI_{CUM}$)] |

### TO COMPLETE PERFORMANCE INDEX (TCPI) #

$TCPI_{EAC}$ = Work Remaining / Cost Remaining = (BAC – $BCWP_{CUM}$) / (EAC – $ACWP_{CUM}$)

# To Determine Either TCPI or EAC; You May Replace BAC with TAB




TERMINOLOGY

| | | | |
|---|---|---|---|
| NCC | Negotiated Contract Cost | Contract price less profit / fee(s) | |
| AUW | Authorized Unpriced Work | Work contractually approved, but not yet negotiated / definitized | |
| CBB | Contract Budget Base | Sum of NCC and AUW | |
| OTB | Over Target Baseline | Sum of CBB and recognized overrun | |
| TAB | Total Allocated Budget | Sum of all budgets for work on contract = NCC, CBB, or OTB | |
| BAC | Budget At Completion | Total budget for total contract thru any given level | |
| PMB | Performance Measurement Baseline | Contract time-phased budget plan | |
| MR | Management Reserve | Budget withheld by Ktr PM for unknowns / risk management | |
| UB | Undistributed Budget | Broadly defined activities not yet distributed to CAs | |
| CA | Control Account | Lowest CWBS element assigned to a single focal point to plan & control scope / schedule / budget | |
| WP | Work Package | Near-term, detail-planned activities within a CA | |
| PP | Planning Package | Far-term CA activities not yet defined into WPs | |
| BCWS | Budgeted Cost for Work Scheduled | Value of work planned to be accomplished | = PLANNED VALUE |
| BCWP | Budgeted Cost for Work Performed | Value of work accomplished | = EARNED VALUE |
| ACWP | Actual Cost of Work Performed | Cost of work accomplished | = ACTUAL COST |
| EAC | Estimate At Completion | Estimate of total cost for total contract thru any given level; may be generated by Ktr, PMO, DCMA, etc. = $EAC_{Ktr\,/\,PMO\,/\,DCMA}$ | |
| LRE | Latest Revised Estimate | Ktr's EAC or $EAC_{Ktr}$ | |
| SLPP | Summary Level Planning Package | Far-term activities not yet defined into CAs | |
| TCPI | To Complete Performance Index | Efficiency needed from 'time now' to achieve an EAC | |

**EVM POLICY:** DoDI 5000.2, Table E3.T2 . EVMS in accordance with ANSI/EIA-748 is required for cost or incentive contracts, subcontracts, intra-government work agreements, & other agreements valued ≥ $20M (Then-Yr $). EVMS contracts > $50M (TY $) require that the EVM system be formally validated by the cognizant contracting officer. Additional Guidance in Defense Acquisition Guidebook and the Earned Value Management Implementation Guide (EVMIG). EVMS is discouraged on Firm-Fixed Price, Level of Effort, & Time & Material efforts regardless of dollar value.

**EVM CONTRACTING REQUIREMENTS:**

DFAR Clauses - 252.242-7001 for solicitations and 252.242-7002 for solicitations and contracts
Contract Performance Report – DI-MGMT-81466A * 5 Formats (WBS, Organization, Baseline, Staffing & Explanation)
Integrated Master Schedule – DI-MGMT-81650 *
Integrated Baseline Review (IBR) - Mandatory for all EVMS contracts > $20M
* See the EVMIG for CPR and IMS tailoring guidance.

EVM Home Page = https://acc.dau.mil/evm
DAU POC: (703) 805-5259 (DSN 655)
eMail Address: EVM@dau.mil
Revised February 2006

# Appendix B. Summary of DAES Data

| Count of Contract Entries | |
|---|---|
| Program Name | Number of Contract Entries |
| 5-INCH GUIDED PROJECTILE | 13 |
| A-10 | 38 |
| A-12 | 9 |
| AAAM | 16 |
| ABRAMS Tank M1/M1A1 | 78 |
| ACM | 82 |
| ADDS | 68 |
| advanced amphibious assault vehicle (AAAV) | 20 |
| Advanced Extremely High Frequency Satellite (AEHF) | 10 |
| Advanced Threat Infrared Countermeasures / Common Missile Warning System | 25 |
| AFATDS | 2 |
| AFATDS (ATCCS) | 49 |
| AH-64 Apache | 195 |
| AHIP Kiowa Warrior | 14 |
| Aim-9X Short range air to air missile | 35 |
| Airborne Laser (ABL) | 23 |
| ALCM | 91 |
| AMRAAM (AIM-120A) | 175 |
| AN/BSY-1 | 76 |
| AN/BSY-2 | 26 |
| AN/SQQ-89 | 206 |
| AN/TTC-39 | 28 |
| AN-APG-79 Active Electronically Scanned Array Radar | 2 |
| AOE 6 | 73 |
| Army TACMS | 65 |
| ASAS (ATCCS) Block IIB III | 49 |
| ASAT | 83 |
| ASPJ (AN/ALQ-165) | 45 |
| ATACMS BLK II | 104 |
| ATS | 29 |
| AV-8B Harrier II | 28 |
| B-1 CMUP-DSUP | 2 |
| B-1B | 432 |
| B-1B CMUP | 62 |
| B-2A | 15 |
| BFVS A3 Upgrade | 29 |
| BFVS M2 M3 (Bradley Fighting Vehicle | 129 |
| C/MH-53E | 55 |
| C-130 Avionics Modernization Program ((C-130 AMP) | 2 |
| C-17A | 291 |
| CAPTOR (MK 60 MINE) | 84 |
| CG 47 Aegis Cruiser | 243 |
| CH-47 Improved Cargo Helicopter (CH-47F) | 13 |

| | |
|---|---|
| CH-47D Chinook | 46 |
| Chem Demil | 122 |
| CHEYENNE | 18 |
| CMU | 115 |
| Comanche Reconnaissance Attack Helicopter (RAH-66) | 102 |
| Cooperative Engagement Capability (CEC) | 53 |
| COPPERHEAD | 39 |
| CRUSADER | 27 |
| CSRL | 23 |
| CSSCS | 21 |
| CVN 68 | 66 |
| DD 963 | 7 |
| DD(X) Destroyer | 3 |
| DDG 51 | 499 |
| DMSP | 176 |
| DSCS III A&B | 65 |
| DSP | 294 |
| E-2C Computer Upgrade | 63 |
| E-3 AWACS RSIP | 73 |
| E-3A Hawkeye | 125 |
| E-4 (AABNCP) | 34 |
| EF-111A | 35 |
| EJS | 13 |
| EMSP | 12 |
| F/A-18 C/D | 112 |
| F/A-18 E/F Super Hornet | 129 |
| F/A-22 raptor | 91 |
| F-14D | 35 |
| F-15 | 221 |
| F-16 | 270 |
| F-35 Joint Strike Fighter (JSF) | 6 |
| FAAD C2I | 64 |
| FAAD NLOS Fiber Optic Guided-Missile | 7 |
| FBCB2 | 19 |
| FDS | 60 |
| FFG-7 | 271 |
| Future Aircraft Carrier CVN 21 | 2 |
| GBS | 17 |
| GLCM | 58 |
| Global Hawk Unmanned aerial Vehicle | 2 |
| GMLRS Upgrade Missile | 13 |
| HARM (NAVY) | 51 |
| Harpoon A/R/UGM-84 | 24 |
| IAV (Stryker) | 6 |
| Inertial Upper Stage | 29 |
| IR Maverick | 58 |
| I-S/A AMPE | 13 |
| Javelin | 71 |
| JDAM | 30 |

| | |
|---|---|
| JGL Tacit Rainbow | 27 |
| Joint air to surface Standoff Missile (JASSM) | 16 |
| Joint Primary training aircraft (JPATS) (T-45) | 88 |
| Joint standoff weapon (JSOW) | 61 |
| Joint Tactical Information Distribution System | 36 |
| JSIMS | 24 |
| JSIPS CIGSS | 22 |
| JSTARS | 181 |
| JSTARS Common Ground Station (CGS) | 26 |
| JTIDS (NAVY) | 23 |
| KC-135R | 53 |
| LAMPS MKIII | 74 |
| LANCE | 13 |
| Laser Hellfire | 119 |
| LCAC | 155 |
| LHD-1 | 151 |
| Longbow Apache FCR | 73 |
| Longbow Hellfire | 21 |
| LPD-17 | 45 |
| LSD 41 CARGO VAR | 26 |
| LSD 41 Class CV | 24 |
| M1A2 Abrams Upgrade | 10 |
| MARK XV IFF | 33 |
| MAVERICK (LASER) | 12 |
| MCM 1 | 37 |
| MCS IV | 25 |
| MH-60R | 76 |
| MH-60S | 9 |
| MHC 51 | 112 |
| MIDS-LVT | 43 |
| MILSTAR | 49 |
| Minuteman III Guidance replacement Program (MMIII GRP) | 90 |
| Minuteman III Propulsion replacement program (MMII PRP) | 53 |
| MK 48 ADCAP | 46 |
| MK 50 Torpedo | 84 |
| MLRS | 82 |
| MLRS-TGW | 57 |
| MP RTIP | 4 |
| Must Fix | 143 |
| National Polar Orbiting operational; environmental | 28 |
| NATO PHM | 20 |
| Navistar Global Positioning system (GPS) II Modern | 306 |
| Navy Area TMBD | 70 |
| NMD | 61 |
| NSSN New Attack Sub | 167 |
| NTW | 12 |
| OTH-B (Radar) | 52 |
| P-7A | 6 |
| PATRIOT | 270 |

| | |
|---|---|
| Patriot PAC-3 | 142 |
| Peacekeeper | 868 |
| PERSHING II | 97 |
| PHALANX CIWS (MK-15) | 40 |
| Phoenix (AIM-54C) | 16 |
| PLSS | 25 |
| Rail Garrison | 48 |
| ROLAND | 32 |
| ROTHR | 3 |
| RPV (AQUILA) | 68 |
| SADARM | 87 |
| SCAMP | 10 |
| SEA LANCE | 33 |
| SEALIFT | 123 |
| Sensor Fused Weapon | 83 |
| SGT YORK GUN (DIVAD) | 31 |
| SIDEWINDER (AIM-9L) (Navy) | 24 |
| SIDEWINDER (AIM-9M) (Navy) | 1 |
| SINCGARS | 38 |
| SLAT (AQM-127A) | 12 |
| SM 2 (BLKS I-IV) | 98 |
| Small ICBM | 234 |
| SMART-T | 20 |
| SOTAS | 17 |
| Space based infra red surveillance system (SBIRS) | 37 |
| SPARROW (AIM-7M) (Navy) | 28 |
| SRAM T AGM 131A/B | 17 |
| SSDS | 20 |
| SSN 688 Attack Sub | 261 |
| STINGER | 126 |
| STINGER RMP | 56 |
| SURTASS | 9 |
| T-45TS | 21 |
| T-46A | 34 |
| TACFIRE | 7 |
| TACIT RAINBOW (JGL) | 3 |
| TACTAS | 2 |
| Tactical Tomahawk Missile | 14 |
| T-AGOS | 20 |
| T-AO 187 OILER | 26 |
| Terminal High altitude area defense (THAAD) | 75 |
| Titan IV | 91 |
| Tomahawk R/UGM-109 | 338 |
| TOW 2 | 19 |
| TRIDENT II MSL | 392 |
| TRIDENT II SUB | 157 |
| TRIDENT SUB | 72 |
| UH-60A/L Black Hawk | 135 |
| USMC H-1 Upgrades | 17 |

| | |
|---|---|
| V-22 Joint services advanced vertical lift aircraft | 210 |
| Virginia Class Sub SSN 774 | 84 |
| WWMCCS Info System | 53 |

## Appendix C: Part of the Employment Rates by State

### Annual average employment in thousands

| State | Industry | Year | employment |
|---|---|---|---|
| Alabama | Transportation Equipment | 1970 | 22.7 |
| Alabama | Transportation Equipment | 1971 | 20.8 |
| Alabama | Transportation Equipment | 1972 | 18.8 |
| Alabama | Transportation Equipment | 1973 | 20.8 |
| Alabama | Transportation Equipment | 1974 | 21.5 |
| Alabama | Transportation Equipment | 1975 | 19.6 |
| Alabama | Transportation Equipment | 1976 | 17.8 |
| Alabama | Transportation Equipment | 1977 | 17.9 |
| Alabama | Transportation Equipment | 1978 | 20.5 |
| Alabama | Transportation Equipment | 1979 | 23.5 |
| Alabama | Transportation Equipment | 1980 | 23.1 |
| Alabama | Transportation Equipment | 1981 | 23.7 |
| Alabama | Transportation Equipment | 1982 | 22.6 |
| Alabama | Transportation Equipment | 1983 | 21.7 |
| Alabama | Transportation Equipment | 1984 | 25.4 |
| Alabama | Transportation Equipment | 1985 | 26.3 |
| Alabama | Transportation Equipment | 1986 | 27.5 |
| Alabama | Transportation Equipment | 1987 | 28.6 |
| Alabama | Transportation Equipment | 1988 | 29.8 |
| Alabama | Transportation Equipment | 1989 | 29.7 |
| Alabama | Transportation Equipment | 1990 | 30.1 |
| Alabama | Transportation Equipment | 1991 | 28.4 |
| Alabama | Transportation Equipment | 1992 | 27.5 |
| Alabama | Transportation Equipment | 1993 | 27.8 |
| Alabama | Transportation Equipment | 1994 | 27.7 |
| Alabama | Transportation Equipment | 1995 | 27.9 |
| Alabama | Transportation Equipment | 1996 | 26.7 |
| Alabama | Transportation Equipment | 1997 | 26.8 |
| Alabama | Transportation Equipment | 1998 | 28.0 |
| Alabama | Transportation Equipment | 1999 | 29.3 |
| Alabama | Transportation Equipment | 2000 | 29.9 |
| Alabama | Transportation Equipment | 2001 | 29.9 |
| Alabama | Transportation Equipment | 2002 | 32.6 |

## Annual average employment in thousands

| State | Industry | Year | employment |
|---|---|---|---|
| Arizona | Aircraft and Missiles | **1970** | **11.8** |
| Arizona | Aircraft and Missiles | 1971 | 11.7 |
| Arizona | Aircraft and Missiles | 1972 | 11.2 |
| Arizona | Aircraft and Missiles | 1973 | 11.4 |
| Arizona | Aircraft and Missiles | 1974 | 12.4 |
| Arizona | Aircraft and Missiles | 1975 | 12.1 |
| Arizona | Aircraft and Missiles | 1976 | 11.9 |
| Arizona | Aircraft and Missiles | 1977 | 12.4 |
| Arizona | Aircraft and Missiles | 1978 | 13.0 |
| Arizona | Aircraft and Missiles | 1979 | 14.8 |
| Arizona | Aircraft and Missiles | 1980 | 16.9 |
| Arizona | Aircraft and Missiles | 1981 | 17.9 |
| Arizona | Aircraft and Missiles | 1982 | 17.7 |
| Arizona | Aircraft and Missiles | 1983 | 17.7 |
| Arizona | Aircraft and Missiles | 1984 | 19.8 |
| Arizona | Aircraft and Missiles | 1985 | 22.6 |
| Arizona | Aircraft and Missiles | 1986 | 26.8 |
| Arizona | Aircraft and Missiles | 1987 | 27.4 |
| Arizona | Aircraft and Missiles | 1988 | 26.2 |
| Arizona | Aircraft and Missiles | 1989 | 26.4 |
| Arizona | Aircraft and Missiles | 1990 | 27.4 |
| Arizona | Aircraft and Missiles | 1991 | 27.2 |
| Arizona | Aircraft and Missiles | 1992 | 25.0 |
| Arizona | Aircraft and Missiles | 1993 | 23.5 |
| Arizona | Aircraft and Missiles | 1994 | 24.7 |
| Arizona | Aircraft and Missiles | 1995 | 25.1 |
| Arizona | Aircraft and Missiles | 1996 | 26.2 |
| Arizona | Aircraft and Missiles | 1997 | 27.1 |
| Arizona | Aircraft and Missiles | 1998 | 29.6 |
| Arizona | Aircraft and Missiles | 1999 | 30.8 |
| Arizona | Aircraft and Missiles | 2000 | 32.3 |
| Arizona | Aircraft and Missiles | 2001 | 33.1 |
| Arizona | Aircraft and Missiles | 2002 | 32.1 |

## Appendix D: Categories of missing data - Methodology used for replacing them

a. Employment rates for the years of 1970 and 1971 were missing: Twenty seven states faced this problem. This research replaced the missing data as follows:

- 1971: The missing data was replaced by the average of the first five years after 1971.
- 1970: The missing data was replaced by the average of the first five years after 1970, using the value calculated for 1971.

b. Employment rates for the years of 1970 to 1987 were missing: Eight states faced this problem. The same technique described above used to replace the missing data.

c. Employment rates for the following states were missing:

- Colorado: From 1988 to 1989.
- Maine: From 1990 to 1994.
- New Hampshire: From 1990 to 1994 and from 1998 to 2002.
- South Carolina: From 1996 to 1999.
- West Virginia: From 1983 to 1987.

This research interpolated the missing data by using the following equation number (13):

$$Rate_{missing} = Rate_{(known\ \ prior\ \ the\ \ missing)} + \frac{(Rate_{known\ \ upper} - Rate_{(known\ \ lower)})}{(Year_{known\ \ upper} - Year_{known\ \ lower})}$$

For example let's calculate the missing data from Colorado:

| | |
|---|---|
| 1987 | 17.9 |
| 1988 | ? |
| 1989 | ? |
| 1990 | 18.8 |

The missing data are the rates for the years 1988 and 1989.

$Rate_{missing} = Year_{1988}$

$Rate_{(known\ prior\ the\ missing)} = Year_{1987}$=17.9

$Rate_{(known\ upper)} = Year_{1990}$=18.8

$Rate_{(known\ lower)} = Year_{1987}$=17.9

$(Year_{known\ upper} - Year_{known\ lower}$ =1990-1987=3

$Rate_{missing} = Year_{1988}$=17.9+ (18.8-17.9)/3=**18.2**

$Rate_{missing} = Year_{1989}$=18.2+(18.8-17.9)/3=**18.5**

d. There were five states for which there weren't any data available and no indication that these states had establishments that could be registered in the Transportation Equipment sector of the Manufacturing Industry. For these states we assigned zero employment rates. These states were the following:

e. Finally for the state of Arizona the only available data where for employment rates of the Aircraft and Missiles sector which is a sub sector of the Transportation sector of the Manufacturing industry. We assumed that the Aircraft and Missile sector can represent the changes of employment over the years for the whole Transportation sector.

The following table shows the states that faced missing data problems

| CATEGORIES OF MISSING DATA | STATES FACING THIS PROBLEM |
|---|---|
| (a) | Arizona, California, Colorado, Delaware, Florida, Georgia, Idaho, Illinois, Iowa, Kansas, Louisiana, Maine, Minnesota, Missouri, Nebraska, New Hampshire, North Carolina, North Dakota, Oregon, Pennsylvania, Puerto Rico, Rhode Island, South Carolina, Utah, |

| | |
|---|---|
| | Vermont, Washington, Wisconsin |
| (b) | Delaware, Idaho, Maine, New Hampshire, North Dakota, Puerto Rico , Vermont, West Virginia |
| (c) | Colorado, Maine, New Hampshire, South Carolina, West Virginia |
| (d) | Guam, Virgin Islands, Hawaii, Wyoming, Alaska |
| (e) | Arizona |

## Appendix E. DoD Budget Summary

All budget figures represent Total Obligation Authority as reported in various tables from Chapter 6 of the DoD Greenbook which is published annually in support of the Presidents Budget submission. Budget data is in millions of FY2006 dollars.

| DoD TOTAL OBLIGATION AUTHORITY (TOA) in millions of FY 2006 dollars | | | | | | |
|---|---|---|---|---|---|---|
| Year | Total Budget | Total Budget % | Procurement Budget | Procurement Budget % | R&D Budget | R&D Budget |
| 1969 | **447,732** | | 102,539 | | 37,120 | |
| 1970 | **410,276** | **-0.0913** | 85,382 | **-0.2009** | 33,865 | **-0.0961** |
| 1971 | **374,350** | **-0.0960** | 73,536 | **-0.1611** | 31,021 | **-0.0917** |
| 1972 | **360,503** | **-0.0384** | 74,618 | **0.0145** | 31,415 | **0.0126** |
| 1973 | **343,874** | **-0.0484** | 68,217 | **-0.0938** | 31,273 | **-0.0045** |
| 1974 | **327,655** | **-0.0495** | 60,280 | **-0.1317** | 29,169 | **-0.0722** |
| 1975 | **315,316** | **-0.0391** | 54,440 | **-0.1073** | 27,806 | **-0.0490** |
| 1976 | **324,113** | **0.0271** | 61,408 | **0.1135** | 28,362 | **0.0196** |
| 1977 | **334,735** | **0.0317** | 71,909 | **0.1460** | 28,901 | **0.0186** |
| 1978 | **337,310** | **0.0076** | 75,608 | **0.0489** | 29,156 | **0.0087** |
| 1979 | **336,680** | **-0.0019** | 72,645 | **-0.0408** | 28,140 | **-0.0361** |
| 1980 | **342,632** | **0.0174** | 73,575 | **0.0126** | 27,891 | **-0.0089** |
| 1981 | **377,728** | **0.0929** | 90,256 | **0.1848** | 31,539 | **0.1157** |
| 1982 | **416,278** | **0.0926** | 112,313 | **0.1964** | 36,000 | **0.1239** |
| 1983 | **444,010** | **0.0625** | 128,682 | **0.1272** | 39,310 | **0.0842** |
| 1984 | **464,237** | **0.0436** | 134,898 | **0.0461** | 44,583 | **0.1183** |
| 1985 | **482,693** | **0.0382** | 141,306 | **0.0453** | 49,212 | **0.0941** |
| 1986 | **475,112** | **-0.0160** | 133,124 | **-0.0615** | 52,483 | **0.0623** |
| 1987 | **469,563** | **-0.0118** | 122,905 | **-0.0831** | 54,305 | **0.0335** |
| 1988 | **461,540** | **-0.0174** | 116,726 | **-0.0529** | 53,899 | **-0.0075** |
| 1989 | **450,393** | **-0.0247** | 108,758 | **-0.0733** | 52,345 | **-0.0297** |
| 1990 | **437,809** | **-0.0287** | 105,289 | **-0.0329** | 48,366 | **-0.0823** |
| 1991 | **443,636** | **0.0131** | 91,494 | **-0.1508** | 45,297 | **-0.0677** |
| 1992 | **401,390** | **-0.1052** | 77,462 | **-0.1812** | 48,069 | **0.0577** |
| 1993 | **372,166** | **-0.0785** | 65,731 | **-0.1785** | 47,183 | **-0.0188** |
| 1994 | **339,856** | **-0.0951** | 52,645 | **-0.2486** | 42,351 | **-0.1141** |
| 1995 | **336,871** | **-0.0089** | 50,940 | **-0.0335** | 41,397 | **-0.0230** |
| 1996 | **330,440** | **-0.0195** | 50,559 | **-0.0075** | 41,426 | **0.0007** |
| 1997 | **322,582** | **-0.0244** | 49,658 | **-0.0182** | 42,393 | **0.0228** |
| 1998 | **320,152** | **-0.0076** | 51,173 | **0.0296** | 42,706 | **0.0073** |
| 1999 | **329,401** | **0.0281** | 57,120 | **0.1041** | 43,286 | **0.0134** |
| 2000 | **337,723** | **0.0246** | 61,535 | **0.0718** | 43,436 | **0.0034** |
| 2001 | **351,095** | **0.0381** | 68,869 | **0.1065** | 46,063 | **0.0570** |
| 2002 | **394,964** | **0.1111** | 68,434 | **-0.0064** | 52,716 | **0.1262** |

## Appendix F. Annual Unexpected Inflation

| | Actual Inflation | Expected Inflation | Unexpected Inflation |
|---|---|---|---|
| 1980 | 11.7% | 5.9% | 5.8% |
| 1981 | 10.4% | 8.1% | 2.3% |
| 1982 | 7.5% | 8.9% | -1.4% |
| 1983 | 3.6% | 6.3% | -2.7% |
| 1984 | 3.0% | 3.7% | -0.7% |
| 1985 | 3.3% | 4.5% | -1.2% |
| 1986 | 2.6% | 4.0% | -1.4% |
| 1987 | 2.9% | 3.4% | -0.5% |
| 1988 | 3.6% | 4.5% | -0.9% |
| 1989 | 3.9% | 3.4% | 0.5% |
| 1990 | 3.0% | 3.0% | 0.0% |
| 1991 | 4.6% | 4.0% | 0.6% |
| 1992 | 1.9% | 2.9% | -1.0% |
| 1993 | 2.9% | 3.7% | -0.8% |
| 1994 | 2.3% | 2.0% | 0.3% |
| 1995 | 2.0% | 2.2% | -0.2% |
| 1996 | 2.2% | 2.8% | -0.6% |
| 1997 | 2.2% | 2.6% | -0.4% |
| 1998 | 2.3% | 2.2% | 0.1% |
| 1999 | 2.2% | 2.0% | 0.2% |
| 2000 | 2.5% | 2.2% | 0.3% |
| 2001 | 3.0% | 2.8% | 0.2% |
| 2002 | 2.7% | 3.0% | -0.3% |

# Appendix G. Annual Gross Domestic Product (GDP)

**Current-Dollar and "Real" Gross Domestic Product**
(Seasonally adjusted annual rates)

| ANNUAL GROSS DOMESTIC PRODUCT (GDP) | | | |
|---|---|---|---|
| YEAR | GDP in billions of current dollars | GDP in billions of chained 2000 dollars | % change |
| 1962 | 585.6 | 2,715.2 | |
| 1963 | 617.7 | 2,834.0 | 4.38% |
| 1964 | 663.6 | 2,998.6 | 5.81% |
| 1965 | 719.1 | 3,191.1 | 6.42% |
| 1966 | 787.8 | 3,399.1 | 6.52% |
| 1967 | 832.6 | 3,484.6 | 2.52% |
| 1968 | 910.0 | 3,652.7 | 4.82% |
| 1969 | 984.6 | 3,765.4 | 3.09% |
| 1970 | 1,038.5 | 3,771.9 | 0.17% |
| 1971 | 1,127.1 | 3,898.6 | 3.36% |
| 1972 | 1,238.3 | 4,105.0 | 5.29% |
| 1973 | 1,382.7 | 4,341.5 | 5.76% |
| 1974 | 1,500.0 | 4,319.6 | -0.50% |
| 1975 | 1,638.3 | 4,311.2 | -0.19% |
| 1976 | 1,825.3 | 4,540.9 | 5.33% |
| 1977 | 2,030.9 | 4,750.5 | 4.62% |
| 1978 | 2,294.7 | 5,015.0 | 5.57% |
| 1979 | 2,563.3 | 5,173.4 | 3.16% |
| 1980 | 2,789.5 | 5,161.7 | -0.23% |
| 1981 | 3,128.4 | 5,291.7 | 2.52% |
| 1982 | 3,255.0 | 5,189.3 | -1.94% |
| 1983 | 3,536.7 | 5,423.8 | 4.52% |
| 1984 | 3,933.2 | 5,813.6 | 7.19% |
| 1985 | 4,220.3 | 6,053.7 | 4.13% |
| 1986 | 4,462.8 | 6,263.6 | 3.47% |
| 1987 | 4,739.5 | 6,475.1 | 3.38% |
| 1988 | 5,103.8 | 6,742.7 | 4.13% |
| 1989 | 5,484.4 | 6,981.4 | 3.54% |
| 1990 | 5,803.1 | 7,112.5 | 1.88% |
| 1991 | 5,995.9 | 7,100.5 | -0.17% |
| 1992 | 6,337.7 | 7,336.6 | 3.33% |
| 1993 | 6,657.4 | 7,532.7 | 2.67% |
| 1994 | 7,072.2 | 7,835.5 | 4.02% |
| 1995 | 7,397.7 | 8,031.7 | 2.50% |
| 1996 | 7,816.9 | 8,328.9 | 3.70% |
| 1997 | 8,304.3 | 8,703.5 | 4.50% |
| 1998 | 8,747.0 | 9,066.9 | 4.18% |
| 1999 | 9,268.4 | 9,470.3 | 4.45% |
| 2000 | 9,817.0 | 9,817.0 | 3.66% |
| 2001 | 10,128.0 | 9,890.7 | 0.75% |
| 2002 | 10,469.6 | 10,048.8 | 1.60% |

# Appendix H: Political Parties Layout

| PARTY LAYOUT | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | HOUSE | SEN. | PRES. PARTY | PRES. PARTY (D=1&R=0) | SEN. & HOUSE SAME PARTY (YES=1&NO=0) | SEN. PARTY (D=1 & R=0) | HOUSE PARTY (D=1 & R=0) | SEN.,HOUSE, PRES.SAME PARTY(YES= 1 NO=0) | SEN., PRES. SAME PARTY (YES=1 NO=0) | HOUSE, PRES. PARTY SAME(YES=1 NO=0) | PROD. TO SERV. CONTR. (PRIOR TO 1992=1 AFTER 1992=0) |
| 1970 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1971 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1972 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1973 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1974 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1975 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1976 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1977 | D | D | D | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1978 | D | D | D | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1979 | D | D | D | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1980 | D | D | D | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1981 | D | R | R | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1982 | D | R | R | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1983 | D | R | R | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1984 | D | R | R | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1985 | D | R | R | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1986 | D | R | R | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1987 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1988 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1989 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1990 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1991 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1992 | D | D | R | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1993 | D | D | D | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1994 | D | D | D | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1995 | R | R | D | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | R | R | D | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | R | R | D | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | R | R | D | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | R | R | D | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | R | R | D | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | R | D | R | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 2002 | R | D | R | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |

## Appendix I: Model Variables

| MODEL VARIABLES | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RESEARCH VARIABLE | PREDICTOR VARIABLES | | | | | | | | | | CONTROL VARIABLES | | |
| YEARS | DOD CV*100 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1970 | 1.718213058 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.30073 | 0.83871 | -0.091295 | | 0.001726 |
| 1971 | 4.758258587 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.22857 | 0.874438 | -0.095967 | | 0.03359 |
| 1972 | 1.527175543 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.28527 | 0.86988 | -0.03841 | | 0.052942 |
| 1973 | 2.996853304 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.26335 | 0.842055 | -0.04836 | | 0.057613 |
| 1974 | 2.213590755 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.26665 | 0.834603 | -0.049499 | | -0.005044 |
| 1975 | 1.869613239 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.27267 | 0.765782 | -0.039132 | | -0.001945 |
| 1976 | 2.429720536 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.26909 | 0.768456 | 0.0271414 | | 0.05328 |
| 1977 | 6.646380042 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.20219 | 0.707727 | 0.0317326 | | 0.046158 |
| 1978 | 1.557917898 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.19976 | 0.700944 | 0.007635 | | 0.055678 |
| 1979 | 2.056782195 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.39046 | 0.752644 | -0.001872 | | 0.031585 |
| 1980 | 5.177439042 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.38692 | 0.747236 | 0.0173729 | 0.058 | -0.002262 |
| 1981 | 5.781732636 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0.39744 | 0.746404 | 0.0929124 | 0.023 | 0.025186 |
| 1982 | 4.522014351 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0.4071 | 0.748563 | 0.0926061 | -0.01 | -0.019351 |
| 1983 | 1.321705096 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0.57984 | 0.836561 | 0.062457 | -0.03 | 0.045189 |
| 1984 | 3.010474668 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0.59631 | 0.83798 | 0.0435707 | -0.01 | 0.071868 |
| 1985 | 3.71130039 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0.63501 | 0.831221 | 0.0382368 | -0.01 | 0.0413 |
| 1986 | 5.996900645 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0.63658 | 0.82888 | -0.015956 | -0.01 | 0.034673 |
| 1987 | 2.86137443 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.62539 | 0.871902 | -0.011818 | -0.01 | 0.033767 |
| 1988 | 4.690168276 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.6158 | 0.861214 | -0.017382 | -0.01 | 0.041328 |
| 1989 | 7.33471227 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.62486 | 0.881446 | -0.024749 | 0.005 | 0.035401 |
| 1990 | 14.42606352 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.62903 | 0.877049 | -0.028745 | 0 | 0.018778 |
| 1991 | 22.93158505 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0.4561 | 0.867244 | 0.0131352 | 0.006 | -0.001687 |
| 1992 | 18.06432989 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0.46733 | 0.86586 | -0.10525 | -0.01 | 0.033251 |
| 1993 | 19.85523474 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0.5195 | 0.812136 | -0.078523 | -0.01 | 0.026729 |
| 1994 | 14.35674752 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0.52724 | 0.815677 | -0.09507 | 0.003 | 0.040198 |
| 1995 | 9.763562393 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.54758 | 0.76522 | -0.00886 | -0 | 0.02504 |
| 1996 | 3.041802789 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.54381 | 0.766567 | -0.019462 | -0.01 | 0.037003 |
| 1997 | 2.701994078 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.48028 | 0.768885 | -0.02436 | -0 | 0.044976 |
| 1998 | 2.140768625 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.49848 | 0.772608 | -0.007591 | 0.001 | 0.041753 |
| 1999 | 1.939167509 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.39481 | 0.741113 | 0.0280786 | 0.002 | 0.044492 |
| 2000 | 2.465251417 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.40531 | 0.733757 | 0.0246402 | 0.003 | 0.036609 |
| 2001 | 3.217070577 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0.34357 | 0.661413 | 0.0380875 | 0.002 | 0.007507 |
| 2002 | 3.586721562 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0.3463 | 0.658623 | 0.1110701 | -0 | 0.015985 |

## RESEARCH VARIABLE

DOD MEAN CO%

## PREDICTOR VARIABLES

1 PRESIDENT PARTY (DEMOCRAT=1 &REBUBLICAN=0
2 SENATE & HOUSE SAME PARTY (YES=1, & NO=0
3 SENATE PARTY (DEMOCRATS=1 & REBUBLICANS=0)
4 HOUSE PARTY (DEMOCRATS=1 & REBUBLICANS=0
5 SENATE, HOUSE & PRESIDENT PARTY (SAME PARTY=1 OTHERWISE=0
6 SENATE AND PRESIDENT PARTY (SAME=1 OTHERWISE=0
7 HOUSE AND PRESIDENT PARTY (SAME=1 OTHERWISE=0)
8 SWITCH FROM PRODUCT CONTRACTS TO SERVICE CONTRACTS (PRIOR TO 1992=1 AFTER 1992=0)
9 MANUFACTURING CAPACITY FOR THE SENATE (SENATE ARMY COMMITTEE/TOTAL TRANSPORTATION INDUSTRY SECTOR)
10 MANUFACTIRING CAPACITY FOR THE HOUSE OF REPRESENTATIVES (ARMY COMMITTEE/TOTAL TRANSPORTATION)

## CONTROL VARIABLES

11 % CHANGE OF DOD BUDGET
12 UNEXPECTED INFLATION
13 % CHANGE OF GDP

## Appendix J: Test for Stationarity of the Independent and Dependent Variables

Time Series data must be stationary. This research checked for stationarity using the Augmented Dickey-Fuller test for Unit Root. For those variables that were non stationary we took the 1st order differences in order to eliminate the unit root. The following table list the results of the tests conducted for all the variables.

| All Contracts (Overrunpercent100) | | | | | |
|---|---|---|---|---|---|
| **Dickey-Fuller test for Unit Root** | | | | | |
| | | | Z(t) has t-distribution | | |
| | Number of Obs | Test Statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value |
| Z(t)-DoDCV100 | 32 | -1.769 | -2.457 | -1.697 | -1.31 |
| p-value for Z(t) = | | 0.0436 | | | |
| Z(t)-Dispersion Measure Senate | 32 | -1.345 | -2.457 | -1.697 | -1.31 |
| p-value for Z(t) = | | 0.0943 | | | |
| Z(t)-Dispersion Measure Senate 1st Order Differencies | 31 | -5.967 | -2.462 | -1.699 | -1.311 |
| p-value for Z(t) = | | 0.0000 | | | |
| Z(t)-Dispersion Measure House of Represenattives | 32 | -0.802 | -2.457 | -1.697 | -1.31 |
| p-value for Z(t) = | | 0.2143 | | | |
| Z(t)-Dispersion Measure House of Represenattives 1st Order Differencies | 31 | -5.533 | -2.462 | -1.699 | -1.311 |
| p-value for Z(t) = | | 0.0000 | | | |
| Z(t)-% Change of DoD Budget | 32 | -1.964 | -2.457 | -1.697 | -1.31 |
| p-value for Z(t) = | | 0.0294 | | | |
| Z(t)-Unexpected Inflation | 32 | -6.01 | -2.528 | -1.725 | -1.325 |
| p-value for Z(t) = | | 0.0000 | | | |
| Z(t)-$ Change of GDP | 32 | -4.698 | -2.457 | -1.697 | -1.31 |
| p-value for Z(t) = | | 0.0000 | | | |

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## Vita

Captain Nikolaos Gounatidis was born in Stuttgart, Germany. He is an Officer in the Hellenic Air force. He graduated from the 2nd Lyceum in Drama, Greece and enrolled in the Hellenic Air Force Academy in 1992. He graduated with a Bachelor in Economics in 1996 and was assigned to the Hellenic Airforce/134 Squadron at Santorini, Greece as an Accounting and Finance Officer until 1998. From 1998 to 2002, he was assigned to the NATO/Joint Command South Cent Larissa, Greece Finance Office where he performed the following duties:

a. 1998 to 1999, Fiscal Officer

b. 1999 to 2000, Budget Officer and Advance Account Holder

c. 2000 to 2001, Purchasing and Contracting Officer

d. 2001 to 2002, Purchasing and Contracting Officer with parallel duties as SO Accounting for the MWA.

From 2002 to 2004 he assigned to the Hellenic Air Force Procurement Agency at Athens, Greece. In August of 2004, Captain Gounatidis entered the Cost Analysis Master's Program at the, Air Force Institute of Technology's School of Engineering and Management. Upon graduation, he will be assigned to the Hellenic General Staff.

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**14. ABSTRACT**

Many of the major programs of the DoD are experiencing cost growth. This research developed an empirical model in order to explain cost overruns. This thesis sought to discover relationships between cost overruns and factors that originate from the political nature of the defense acquisition process. The model describes how the political and legislative balances of power between the parties of the Congress, the change of the purchase habits of the DoD from production to service contracts, and the spreading of defense manufacturing capacity across the U.S are related to cost overruns. This research studied 193 programs from 1970 to 2002 using OLS regression techniques. Results show that a Democratic President leads to a reduction in cost growth, while control of both houses of Congress by one party, or control of the Senate and the office of the President by one party causes cost increases. Furthermore, the results showed that the switch from production to service contracts doesn't reduce cost growth. On the contrary, reduction in the annual cost overrun percentage is observed prior the switch from production to service contracts. Finally research highlighted that the dispersion of defense manufacturing capacity across the country inflates cost overruns in DoD programs.

**15. SUBJECT TERMS**

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